POPULAR SCIENCE

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AUTOMOBILES · HOME & SHOP · MECHANICS

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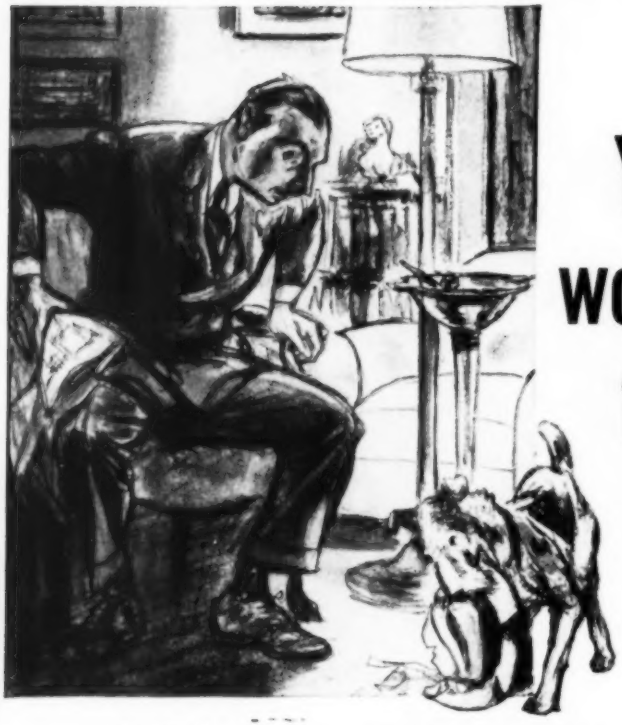
Our Infantry's New Weapons

PAGE 64



You may worry about the dog

but here is one worry you can avoid

The unhappy discovery that Fido has ruined your hat is no more disturbing than that first chassis rattle, which is a blow to the pride in your car.

Chassis squeaks and noises telegraph a warning story that may mean worn steering crank bearings, tie rods and king pins.

You need a chassis lubricant that will stick to its job at those vital points which receive literally tons of road shocks in every mile.

Marfak is that lubricant. It's a special blend of heavy-bodied oils. It's cohesive and adhesive. It outlasts ordinary grease.

When you get a "Marfak job" you get Texaco's 40-Point Chassis Lubrication Service. Every point is covered by an expert trained in a special Texaco lubrication school.

Leave your lubrication worries where you see this sign: "Let Us Marfak Your Car." At Texaco and other good dealers everywhere.

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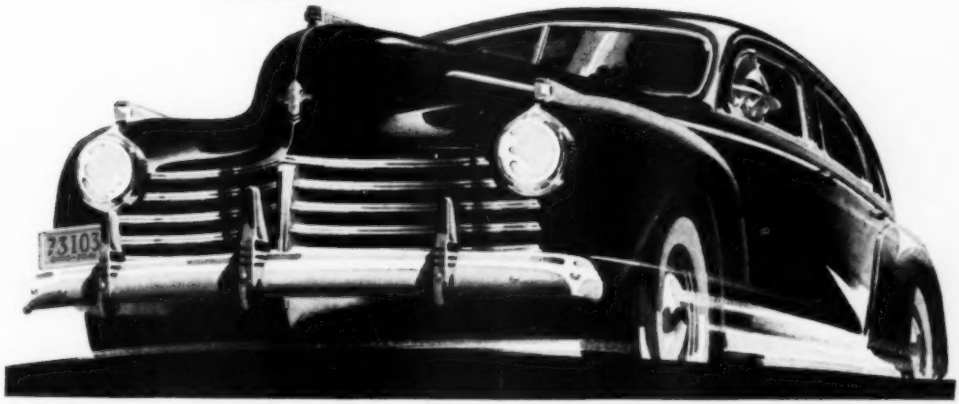
TEXACO'S 40-POINT CHASSIS LUBRICATION SERVICE AT ALL TEXACO AND OTHER GOOD DEALERS

We took a honey of an engine and *ADDED* Fluid Drive!



Try it... See what a difference Fluid Drive makes!

CHRYSLER engineers might have said, "We've got the greatest engine in history in our new Spitfire. It's got thrills enough for anybody." But what they did do was to take that power-packed honey of an engine . . . and *add Fluid Drive to it!*

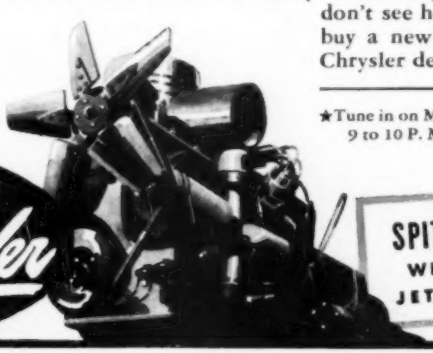
They knew that there is no substitute for *Fluid Drive!* They knew that *Fluid Drive* and Vacamatic transmission could add factors of smoothness, economy, driving ease and thrills beyond anything that could be put inside an engine.

The result is the greatest combination of *engine and drive* that the motoring world has yet seen.

You can drive for hours without touching clutch or gearshift. Glide up to traffic lights . . . put on the brake . . . stand still without touching clutch or gear lever . . . then slip away again simply by touching the throttle! Vacamatic transmission gives you the power you want when you want it.

Don't you owe it to yourself to try this before you drive any new car? Frankly, we don't see how you could possibly buy a new car without it! Your Chrysler dealer invites you!

★Tune in on Major Bowes, CBS, Thursdays, 9 to 10 P. M., Eastern Standard Time



BE MODERN
WITH FLUID DRIVE and Vacamatic Transmission
Buy Chrysler

SPITFIRE ENGINES
WITH MULTIPLE-JET CARBURETORS

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 138 NO. 5

Mechanics & Handicraft

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY

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LIEUT. COL. A. M. PRENTISS, author of "How Homes Can Be Protected from Air Attack," was in the Chemical Warfare Service in the World War and has remained in that branch of the Army ever since, except for details to the General Staff Corps. His book, "Chemicals in War" is a standard work. In 1936 he visited eight European countries, where he gathered information on civil air defense.

EDITOR . . . . . Charles McLendon
MANAGING EDITOR . George H. Waltz, Jr.
HOME WORKSHOP EDITOR . Arthur Wakeling

ASSOCIATES: Carsten Grande, *Art Editor;* Fred O. Newman, *News;* William Morris, *Photography;* Schuyler Van Duyne, *Automobiles;* Alden P. Armagnac, Edwin Teale, David M. Stearns, Harry Walton, *Group Editors;* B. T. Richards, *Copy Editor;* Michele de Santis, Harry Samuels, Stewart Rouse, Michael Cerniello, *Art Assistants.*

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1 Special rock wool insulation in cowl — an exclusive Body by Fisher feature.

2 Felt deadener cemented to dash backed by insulator of jute and fibre board.

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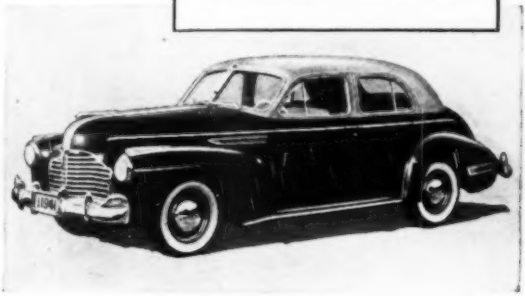
4 Jute pads for extra insulation of floor in front and rear compartments.

5 Felted pads cemented to roof, cowl, door, side, and trunk lid panels.

6 Trunk walls and wheel housings insulated with spray-on deadener, which adheres permanently to curved surfaces.

MOST motorists know the all-weather advantages of famed Fisher No Draft Ventilation. But that's only one of a number of features the new Body by Fisher provides to assure your complete comfort whatever the climate. Note, for instance, the wide variety of methods and materials used for insulation purposes—each scientifically adapted to its particular location in accordance with the most modern developments in sound and temperature control. Add this to the advanced styling, greater roominess and increased solidity of the new Unisteel Turret Top Body by Fisher—and it's easy to see why folks are saying, "Body by Fisher is '41's guide to better value," which leads you, of course, to a General Motors car.

"BEST BUICK YET" is the popular way to describe this 1941 beauty. And one reason for that is its sleeker yet roomier new Body by Fisher—shown here on the Buick SUPER 4-door Sedan. It's a wider, longer body with rear doors hinged at the front for greater safety and may be had in two-tone body colors, if desired, at no extra cost.



UNISTEEL TURRET TOP

BODY BY *Fisher*

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READY WHEN NEEDED

This country has the best telephone equipment in the world and there's plenty of it.

There's plenty of it for the every-day needs of millions of telephone users—with something to spare for emergencies.

For the Bell System has two things of special importance these days. It has experienced, adequate manufacturing facilities and a dependable, nation-wide distributing organization.

Both are handled within the Bell System by Western Electric. This has been a good policy for a generation. Never have its benefits been so clear as right now.

BELL TELEPHONE SYSTEM

THE BELL SYSTEM IS DOING ITS PART IN THE COUNTRY'S PROGRAM OF NATIONAL DEFENSE

Champions are giving dependable service in Uncle Sam's tanks, trucks, motorcycles, cars, and "mosquito fleet." In your own car, Champions give the same dependable performance.

Today the quality and condition of your spark plugs establish to a greater degree than ever before the performance and economy you get from your engine.

Champion's Sillment* seal not only prevents gas or compression leakage which causes overheating, and results in rough, uneven engine performance, but in so doing assures that smooth, economical engine performance which the maker built into it.

Check up on your spark plugs at regular intervals and replace them every 10,000 miles with Champions—the spark plugs champions use—for maximum performance and economy.

No other spark plugs have the patented Sillment seal which keeps Champion Spark Plugs permanently free from troublesome gas or compression leakage *common to ordinary spark plugs.*

You're always ahead with Champion!
SPARK PLUGS

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What about I.C.S. students who are drafted?

MAYBE you've learned that only with *proper training* can you hope to get ahead on your job — maybe you've often said, "Some day I'll take an I. C. S. Course, and really amount to something!"—but because of the draft, you've decided to put it off. *Don't do it!*

If you're drafted, you'll be encouraged to continue your I. C. S. studies — for the U. S. Army, like business and industry, needs trained men—*and pays them well!* Furthermore, you will have real training by the time your term of enlistment is over, and you'll be ready to step into a bigger, better-paying job than you have now.

Figure it out for yourself — training pays in peace-time or war-time, in army or civilian life. Mail this coupon *right now* for information on low-cost I. C. S. Courses in your line of work. *The I. C. S. Limited is headed for Success — climb on!*

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☐ Managing Men at Work
☐ Railway Postal Clerk
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HOME ECONOMICS COURSES

☐ Advanced Dressmaking
☐ Foods and Cookery
☐ Home Dressmaking
☐ Professional Dressmaking and Designing
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City.....*State*.....*Present Position*.....

Canadian residents send coupon to International Correspondence Schools Canadian, Limited, Montreal, Canada
British residents send coupon to I. C. S., 71 Kingsway, London, W. C. 2, England

LOST!

58,279 PIPE SMOKERS

When last seen were blindly groping for a "different" pipe tobacco!

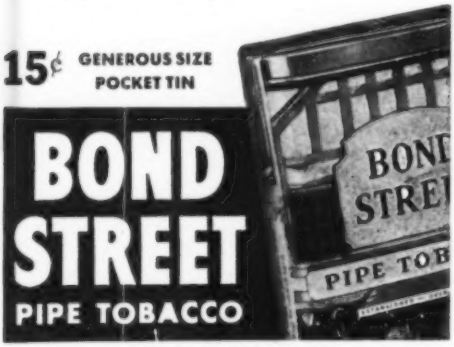
Once they try BOND STREET—the truly *aromatic* blend—most hard-to-please pipe smokers are set for life! That applies to a high percentage of exacting smokers.

Yet—by applying that figure to readers of this magazine—we know there are 58,279 pipe smokers who *still* have this delightful discovery to make. That's why we urge you to try it.

BOND STREET is rich-tasting—bite-free—leaves no pipe odor in the room. It contains a *rare aromatic tobacco not hitherto used in a popular priced mixture.* Even the ladies like its aroma!

Buy a tin—today!

15¢ GENEROUS SIZE POCKET TIN



A Product of Philip Morris

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"What's a Road For?"

FOR a chicken a road is an obstacle to be crossed, but for a man it is a means for overcoming the obstacles of time and distance that tie him to one spot.

It is no accident that the roads that crisscross America form the greatest highway system in the world, that they carry more vehicles than those of any other nation. The roads are there because Americans are an adventurous people, seeking distant horizons and far places. They are there because America is a great continent with distances spanning one-eighth of the globe. They are there because no American is content to *be* less, to *do* less, to *have* less, for himself or for his family, than any other man.

But none of these things alone could have built those millions of miles of roads nor have put millions of automobiles upon them. The roads and the automobiles are there because American industry, interpreting the needs of a people and giving them shape and form, made possible roads that the people could afford to build and maintain, automobiles that the people could afford to buy and run.

For more than 60 years General Electric engineers, scientists, and workmen have helped American industry to satisfy the needs of this restless, robust, growing, active America. In creating More Goods for More People at Less Cost, they have made the dreams of fathers and mothers come true for America's sons and daughters. America lives better, through better things for living. General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

952-119E1-211

GET MORE GAS MILEAGE

Make this test and prove it

With the rear wheels of your car jacked up, the motor started and the hand throttle set so speedometer registers 20 m.p.h. . . . use WHIZ MOTOR RYTHM, following simple directions, and watch that speedometer climb! Up she goes, quickly, to 22 m.p.h. or more! Proving more power. That's MOTOR RYTHM!

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PS51

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For enclosed $1.25, please send* me one quart of MOTOR RYTHM, enough for a complete tune-up. You agree to refund my money if I am not entirely satisfied.

*Postpaid in U.S.A.

Name .....
Street ..... State .....
City ..... Year .....
My car is a ..... (MAKE)

World's Oldest and Largest Manufacturers of Automotive Chemicals

Coming Next Month—

SUBMARINES are not like other warships, which must either outfight or outrun their enemies. How they stalk their prey, strike, and dodge the shattering depth charges is told by Rear Admiral Yates Stirling, leading naval authority, in an article that explains why these relatively inexpensive vessels are the trump card of the weaker sea power in any conflict.

RAY MILLHOLLAND knows machine tools and machine-shop work as well as his fictional character "Blue Chip Haggerty," whose experiences entertain millions of magazine readers. In "Charge of the Iron Brigade" he tells of the vital part that the machine-tool industry plays in our defense program and how it is meeting its gigantic task.

PICNICS WITHOUT ANTS are the reward of building an outdoor fireplace. Whether you are planning an elaborate open-air range or just something that will cook a hamburger, you will find some valuable tips in an article which not only takes you through the construction stage but launches you as an al fresco chef with advice on fuels, cooking tools, and culinary short cuts.

HICKMAN POWELL continues his story of the making of an American pursuit pilot, begun in this issue. Having taken you past the transition from a trainer to a fighter plane, he now initiates you into the fine art of dogfighting. After reading it, you'll have an even greater admiration for the youngsters who man our fast, hard-hitting P-40's.

STOP-AND-GO CHEMICALS that speed up or retard the activity of plants are among the latest and most amazing achievements of science. How these discoveries and developments are giving man new control over farm and garden crops is told in "Miracles of the Plant Chemist."

FIR PLYWOOD and knotty pine can now be finished in beautiful, even colors suited to the most exacting standards of craftsmanship. Home-workshop fans will want to know about the new products that make this possible, and how they are applied. Ralph G. Waring tells you how to put fir plywood and knotty pine among the materials available for your finest work.

WHY SPARK PLUGS NEED CLEANING

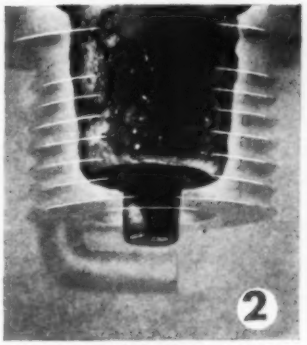
WHITE
Oxide Coating
Cleaning is possible

Oxide coating,—a residue of combustion, which collects on spark plug insulators,—is an electrical conductor when hot. When the engine is pulling hard, or turning at high speed, the temperature of the coating is high, and its conductivity at a peak.

Under these conditions, the spark plugs misfire because the oxide coating intermittently short circuits the current, and the fuel charges in the cylinder are not fired. The misfiring eliminates the heat source, and the temperature drops,—the oxide cools,—and the plug starts firing again.

"Jack-Knife Cleaning" Won't Do

Oxide coating (see pictures 1 and 2) cannot be scraped away. It adheres too tightly to the spark plug insulator. Yet, if not removed at 4,000 mile intervals, it can result in a loss of power as great as 21%, and a gas waste as high as one gallon in ten.



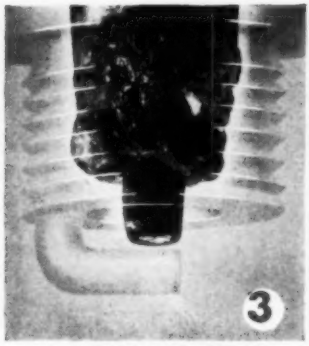
FUSED
Oxide Coating
Cleaning still possible

Registered AC Spark Plug Cleaning Stations (there are 60,000 of them) were established and equipped by AC because of oxide coating. They use a special AC cleaning machine which completely removes this coating in a few seconds. At 5c a plug, their service is a real economy.

Get Plugs CLEANED where you see this Sign

Remedy for Worn or Blistered Plugs

Of course, there comes a time when plugs are too blistered, as in picture 3, or too worn for further good performance. Usually this is around the 10,000 mile mark. Such plugs should be replaced to be sure of peak performance, best fuel mileage, and easy starting.



BLISTERED
Oxide Coating
Too late for cleaning

The QUALITY Spark Plug

More AC's are used as standard factory equipment than any other make of spark plugs

AC SPARK PLUG DIVISION • *General Motors Corporation* • FLINT, MICHIGAN

SCIENTISTS of the University of Chicago Medical School have succeeded in killing bacteria both by spraying them into a mist of propylene glycol, and by spraying the mist onto the bacteria. They hope next to show that the technique will stop the spread of diseases like influenza and colds in crowded places. The mist is odorless and unnoticeable, and retains its effectiveness for at least an hour and a half.

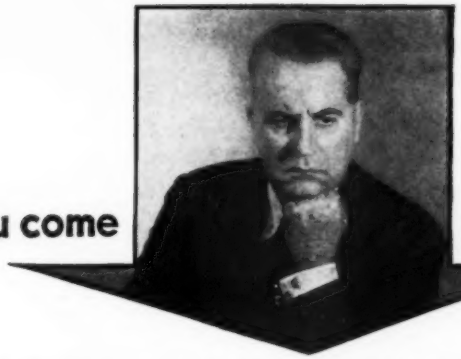
From the News Editor's Desk

THE BIGGEST OVEN-BAKING JOB in history is under way at a White River Valley, Wash., flood-control dam. Three huge oil burners will heat three drums of earth, which will be packed into the core of the dam. All together, 425,000 cubic yards of earth must have its moisture reduced to ten percent, at a cost of $300,000 for fuel oil alone. A special tent will cover the construction area to keep the earth dry after baking.

NO MATTER WHETHER ALCOHOL makes you high-spirited and talkative, or sullen and combative, inhalations of pure gasoline vapors will do the same thing. Dr. A. C. Cornsweet, psycho-physiologist of the University of North Carolina, tried it on himself, and found that to inhale either gasoline or alcohol produced similar symptoms. He isn't sure how gasoline vapors compare with alcohol in liquid form, however; he will have to try further experiments.

IS THE HAY TOO WET TO PUT IN THE BARN? Can the corn be cut and shocked? Any question regarding the amount of moisture in forage and grain crops may now be settled in twenty minutes. Robert Q. Parks, 25-year-old instructor in agronomy at Ohio State University, has invented a device which gives a direct reading of the moisture content of any crop. A chemical, calcium carbide, is added to a sample of the plant tissue, and the loss of weight produced by the reaction is then measured. The device is described as within the price range of any farmer, extremely simple in its operation, and capable of being operated from a fence post. The University's Research Foundation will license its manufacture.

FIVE YEARS OF EXPERIMENTATION at Georgia Tech have produced the decorticator, which may revive the flax industry as Eli Whitney's gin revolutionized cotton growing. The machine removes the wood from flax fiber, and chops the fibers in uniform lengths which can be spun with machinery now used in cotton mills. O. C. Falkovitch and Dan Smith now have the device in the final stages of development. If successful, it will eliminate the slow, unsatisfactory process of "retting," or soaking flax straw in water until the woody portion decomposes.

Have you come  to this point?

Once in almost every man's life there comes the time when he realizes, with the suddenness of a lightning flash, that he isn't getting anywhere . . . that, while time is flying, he is standing still, in a business way . . . with no promotions and a stationary income . . . and that all the while he is growing older, and older, and OLDER.

He may even realize that his failure is due to his lack of special ability, but—if he is like all too many men, he does nothing about it, accepts the whole picture as inevitable, perhaps feels a bit bitter about it, and goes on down.

But—*if he has the right metal in him*—he'll do what thousands of others have done in the last thirty-three years—men who found themselves going round and round in a back eddy—he'll begin at once to qualify himself for a better position (and for still bigger and better positions) by getting special training in his spare time *at home.*

That's the LaSalle way . . .
. . . learn while you earn

and almost inevitably, you'll get more and more money because you'll be worth more and more.

Dramatic life stories . . . stranger, many of them, than fiction . . . are told in thousands of letters in our files—of men climbing from the ranks of common labor to financial independence or professional ranking . . . of thousands lifting themselves from dead-end jobs of hopelessness to the path of rapid promotion and bigger money.

Right now . . . today . . . this very minute . . . there are thousands of well-paying openings for the men qualified to fill them; for there is a definite shortage of highly-trained men—the kind that know what to do and how and when to do it.

During the next ten years, *this shortage will be even greater*—due to rearmament, industrial expansion, and the absence of many men in military service. So—

NOW is the time for YOU to act . . . to say good-bye forever to discouragement, to a fixed low income, to your many money disappointments . . . by checking and mailing the coupon below. What it brings to you will cost you only a postage stamp, but it has been worth a fortune to thousands and CAN be to YOU.

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Readers Say:

How Did Robin Hood Get Along Without Knowing Calculus?

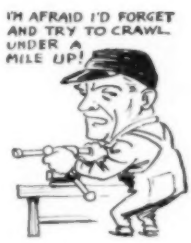
As an archery fan of long standing, I would like to know whether it is possible to calculate the speed of a shaft from a bow of given physical characteristics such as length, cross section and rate of taper of limbs, density, elasticity, etc. Does the draw and force required follow Hookes' law? From calculus I got the idea that there must be a certain cross section (round, oval, or otherwise) and rate of taper of limbs which would yield the greatest speed for a given volume of material. Is this so?—J. S., Corona, N. Y.

Perfect(ly Useless) Vacuum Is Easy To Produce

The subject of producing a perfect vacuum frequently goes the rounds. I would like to present my Grand Scheme for doing it. Usually you start off with a suitable vessel or container and proceed to evacuate the air that's in it with pumps and things. But not me. I'd do it this way: Bore a straight hole through a metal block, like the cylinder in an auto engine block. Fit a piston or plug in the hole. Superfinish the top of the piston and block to a perfectly flat, smooth surface. Next slide a smooth, flat, heavy plate onto the block to cover the piston and bolt this fast. Then move the piston down a distance (against external air pressure) and hold it there. A space is thus created which, if the piston fits closely enough, is airless. Almost any size vacuum could thus be made. The only trouble is, how the heck could you make any practical use of it after you made it? I dunno!—A. V., New York City.

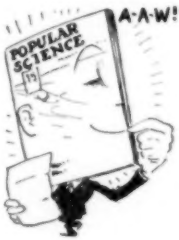
Gus Says: No, Thank You, Cars Are Cranky Enough

What about a model-airplane section? Let Gus Wilson do a little trouble-shooting on gas-model motors and straighten out some of the "bugs" that drive modelers nuts. You told how many fellows are interested in models, so how about a few pages for them every month? And tell why gas models go straight up and come straight down.—R. F., Chicago, Ill.



His Long-Intended Complaint Turned into a "Love Letter"

From time to time, since I started reading your magazine in 1938, I have thought of writing to you with some complaint or other. Then whenever I sat down to write, I found that somebody else had already expressed my thoughts. Ironically enough, this letter I am finally writing turns out to be almost a love letter, your magazine having improved so much in my estimation. First of all, I want to thank you for your homemade "audio telegraph," which I am going to attempt to build with the help of a friend. Then I come to your photography section, which is swell. The only improvement I can ask for in that is to make it larger.—A. A., New York City.



Our Home-Planning Contest Gets a Pat on the Back

I wish to congratulate you on the Home Planning Contest anounced in the February issue. This is without a doubt the finest, most constructive thing that has ever been done by any publication. I have been planning a home for years and intend to have a go at that first prize. My guess is that you'll be surprised at the number of people who will compete; and, I'll bet there'll be some mighty fine ideas submitted.—A. B. R., Philadelphia, Pa.

KNOWLEDGE
THAT HAS
ENDURED WITH THE
PYRAMIDS

A SECRET METHOD FOR THE MASTERY OF LIFE

WHENCE came the knowledge that built the Pyramids and the mighty Temples of the Pharaohs? Civilization began in the Nile Valley centuries ago. Where did its first builders acquire their astounding wisdom that started man on his upward climb? Beginning with naught they overcame nature's forces and gave the world its first sciences and arts. Did their knowledge come from a race now submerged beneath the sea, or were they touched with Infinite inspiration? From what concealed source came the wisdom that produced such characters as Amenhotep IV, Leonardo da Vinci, Isaac Newton, and a host of others?

Today it is known that they discovered and learned to interpret certain *Secret Methods* for the development of their inner power of mind. They learned to command the inner forces within their own beings, and to master life. This secret art of living has been preserved and handed down throughout the ages. Today it is extended to those who dare to use its profound principles to meet and solve the problems of life in these complex times.

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BY THE MAKERS OF MOBILOIL

Readers Say:

Here's One That Will Put Droplets on Your Brow

HERE is a problem that might interest some of the readers of "Our Readers Say": If there are two droplets in a drop and three drips in a droplet; if there are four driplets in a drip and five sprinklets in a driplet; if there are six sprinklets in a sprinkle and seven dewlets in a sprinklet; if there are fifteen foglets in a dewlet; how many foglets are there in a drop? The way I figured, there are 12,600 foglets in a drop; I am fairly sure this answer is not right, though it might possibly be.—R. H., Portland, Ore.

He's Keen for an Article on Razor Honing

A GOOD article for your magazine would be the do's and don't's of honing and stropping a straight razor. At least, I would certainly like to know how.—W. H. H., Roanoke, Va.

We suggest that W. H. H. get his favorite barber to give him a lesson in razor sharpening.—Ed.

If You MUST Be Formal, You Can Wear That Tie

OPERATORS of shop machines needn't remove their ties as F. A., of Dunmore, Pa., warns. I attend a shop class in high school and the safety rules given me state that the tie should be tucked securely into the operator's belt. It is not necessary to remove it. However, F. A.'s letter was interesting just the same.—L. H., New York City.

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$4,000,000 of architect-designed Precision-Built Homes have already been erected. *Without obligation,* write today for Bulletin No. 86. Get the full facts about this new and finer, *engineered* way to build your own home. HOMASOTE COMPANY, Trenton, N. J.

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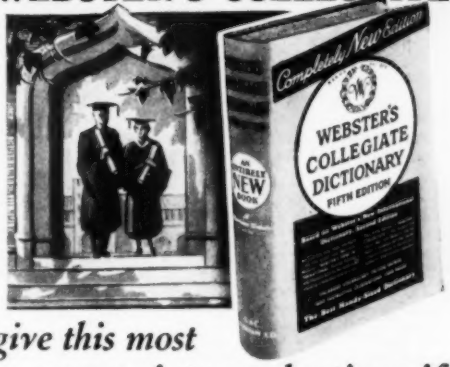

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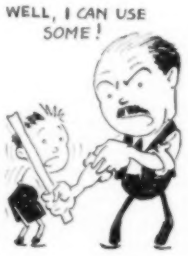
READERS SAY:

Wanted: A Practical Use for Waste Venetian-Blind Slats

WHILE working in the Venetian-blind industry, I have seen literally millions of lineal feet of painted slats thrown away. In making a blind, at least two extra slats are added to allow for rejects, and are afterwards discarded; it does not pay to use them again in blinds, because of the difficulty of matching colors and sizes. The slats are ⅛" thick, 2⅜" wide, and from 10" to 40" long. Perhaps one of your readers can suggest some practical use to which these slats could be put.—J. L. Z., New York City.



Here's News! A Movie Actor Actually Reloads His Gun

W. P. O., of Port Angeles, Wash., says that he has never seen an actor in a western movie reloading his gun. *I have*, and I would like to suggest that he see "The Westerner," in which Gary Cooper is plainly seen loading his gun during the gun battle in the theater with Judge Roy Bean. Such realism should prove interesting to W. P. O., as it did to me. —W. J. D., Rochester, N. Y.

He Doesn't Find a Headache in a Tankful of Problems

AS AN avid reader for 12 years, with an even gross of your invaluable issues, I frequently try the problems sent in by readers. I must be just the opposite of J. M., because these problems have never yet given me a nervous breakdown or even a headache. H. J. A. Jr.'s little problem about the tank took about three minutes of solving and five minutes of wondering what I did wrong to make it so easy. I got 4.285714 minutes or, to be more exact, 4 2/7 minutes, which H. J. A. Jr., can carry out to as many decimal places as he wishes. Many thanks for an excellent magazine. I hope I can be with you for many more dozens of years.—W. R. S., Princeton, N. J.

she does the rhumba on the neon

One night, not long ago, a new dancer appeared on New York's Broadway. Crowds gathered, and laughed, and applauded. She was the newest creation of Douglas Leigh, outdoor sign king famous for his neon fantasies. *Popular Science on-the-screen* shows how the engineers have combined movies with the photo-electric cell to give this gal of the "electric signs that move" real oomph. Don't miss it, gentlemen!

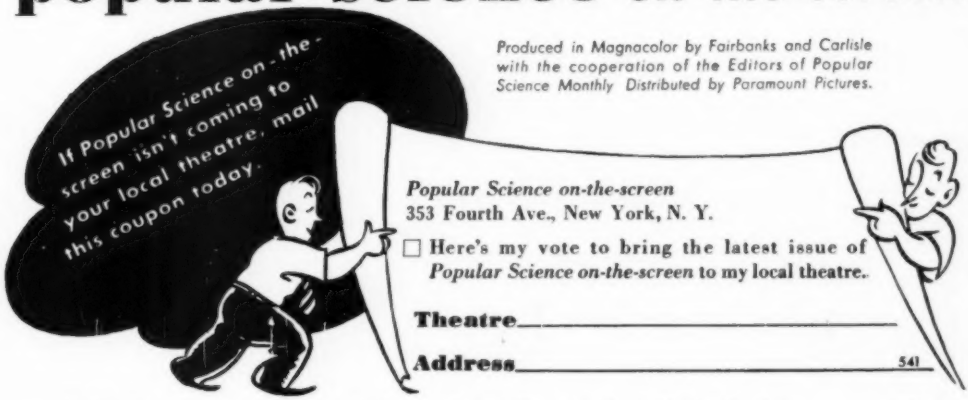
community postman . . . at 125 m. p. h.

Imagine living in a town so remote that even the railroads overlook it . . . but getting your letters by airmail! Not fantastic at all . . . for Uncle Sam's mail service plans to reach these outlying districts with hedge-hopping, non-stop flights that will drop mail by parachute, and pick it up with the flying postman's version of the fishhook . . . all at 125 m.p.h. *Popular Science on-the-screen* tells this dramatic, breath-taking story.

. . . and don't miss the whimsical, sophisticated spoofing of Professor Oakes. In his usual rib-tickling style, he now considers that subject not so humorous to those who have it . . . hay fever!

popular science *on-the-screen*

Produced in Magnacolor by Fairbanks and Carlisle with the cooperation of the Editors of Popular Science Monthly. Distributed by Paramount Pictures.



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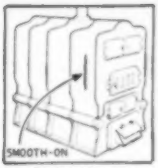
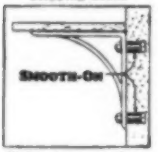
Here's a real necessity in every household



Sealing Cracks

Stopping Leaks



Tightening Loose Parts

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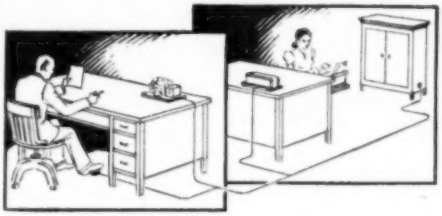
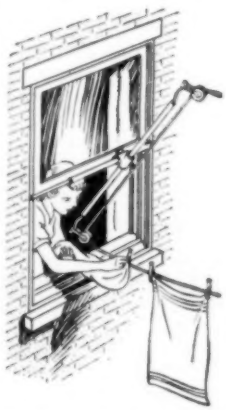
With the Inventors

TOTALING 1,000 pages and including 46 drawings, an application for a recently granted patent covering an office dictation system is believed to be the longest ever filed with the U. S. Patent Office. Under this plan, any person in a company, an office building, or even a whole city, dictates his correspondence to a microphone on his desk.



An electric connection leads to a central station resembling a dial telephone exchange, where his voice automatically is recorded on one of a number of magnetized steel cylinders. At the receiving end, batteries of typists transcribe the dictation of all "subscribers," and the recording cylinders are then magnetically wiped clean for reuse. Refinements of the staggeringly complex mechanism enable a user to dial for any part of a letter he wants played back to him, to erase and correct mistakes, and to talk without interruption while records are shifted. . . HANGING OUT THE WASH on an apartment clothesline becomes less hazardous with the invention of a tilting support, pivoted to the outside of the window frame. When its lower end is drawn inside the opened window, clothing may be attached or detached conveniently, without requiring a housewife to lean out dangerously far. The hanger bar, which carries a pair of pulleys, is then returned to its upright position. A thumb screw permits it to be locked either slantwise or perpendicularly. . . . THE FIRST Pat-



(Continued on page 22)

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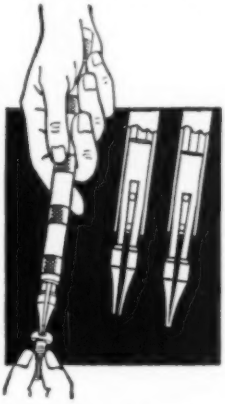
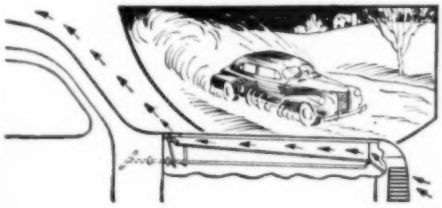
With the Inventors

(Continued from page 20)

ent Office Building, purchased by the U. S. Government in 1810, was the only public building in Washington not burned by the British in 1814. Ironically, it was destroyed by fire in 1836 . . . BY GRASPING A SCREW that it is to drive, a new screw driver makes insertion easy in hard-to-get-at places. When the screw is pressed against the blade, as at left in the illustration, two separable sections of the bit expand as its slotted center is forced back upon a pair of pins in the handle. This gives a firm, resilient grip upon the screw slot until the screw is seated. The other two views show the blade end in expanded and closed position, respectively. Credit for the ingenious invention goes to Walter G. Runge, of Oakland, Calif. . . .



DUST, MIST, AND FLYING INSECTS are diverted from a car's windshield in a scheme devised by Floyd C. Martin, of Jamestown, N. Y. Part of the air entering the radiator grille passes through ducts just beneath the top of the engine hood, and emerges from outlets in an upward stream past the windshield. This air current forms a barrier against particles that otherwise would adhere to the glass, so that the driver is assured of a clean windshield and clear vision. The air outlets may be opened or closed at



will by a convenient hand lever mounted in the cowl. . . . JOINT INVENTORS are entitled to a joint patent. Neither of them can obtain a patent of his own for a device jointly invented by them. . . . FITTING AN APPLIANCE PLUG into a concealed outlet, by the

(Continued on page 24)

INVENTORS

THIS is the time of year when ambitious, forward-thinking men *look ahead*, lay plans for the future that may mature into profitable reality. Last year the record-playing attachment for radios became a reality and sold like "hot cakes" at a low popular price. Women's clothes were almost revolutionized by the introduction of the "house coat." The "electric nurse"—a guard against kidnappers—hit the market with a bang. Portable air-conditioners went up in value, down in price. The gearless hydraulic transmission has become a practicality. Farmers saved thousands of dollars with electric fencing.

Every year brings new inventions. There will be more in 1941. Smart men will plant the seeds of invention into the fields of industry, and reap the harvest when it is ripe. So do your spring "idea planting" early.

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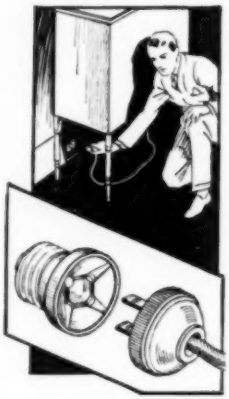
With the Inventors

(Continued from page 22)

sense of touch alone, is made easy by R. O. Bone, of Kansas City, Mo. In a wall plate of his design, both horizontal and vertical slots are provided for insertion of the plug. When the prongs are held against the recessed face of the outlet, and turned slightly, they are automatically guided into one or the other of these pairs of slots. The inventor has also adapted the design to a screw-base connector, as shown in the lower part of the illustration. . . THE TERMS "Patent applied for" and "Patent pending" have no legal standing. An inventor is not protected by the patent law until his patent is actually issued. . . A HAMMER with a V-shaped, undercut slot in its head serves as a holder for starting a nail or tack, in a design worked out by J. T. Lane of Los Angeles, Calif. After an initial sideward stroke, the hammer is slipped away from the nail and used to drive it home in the usual way. By making it unnecessary to hold the nail with the other hand, the hammer facilitates work under many conditions, especially when a nail is to be driven in a place out of easy reach. In addition, short brads and tacks may be inserted without likelihood of mashing a finger or thumb. . . . BABY CAN'T BE PRICKED with a safety pin of new design, according to its Astoria, N. Y., inventors. In the unlikely event that it comes loose from clothing, it automatically closes. Unlike an ordinary safety pin, this one is comparatively rigid throughout, ex-



(Continued on page 26)

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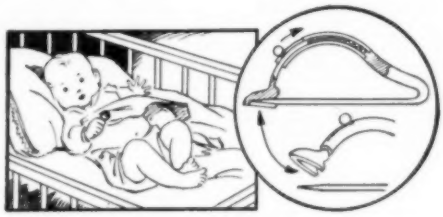
With the Inventors

(Continued from page 24)

cept for a guard member that sheathes the point. To insert the pin in a garment, this sheath is retracted by a small knob. It then snaps back again of its own accord, when



released, under the pressure of a coil spring in the hollow, curved back. . . . NOT EVERYONE MAY KNOW that the U. S. Patent Office has an official seal of its own. Its design, symbolizing "America, agriculture, and industry," consists of an American eagle surmounting a stack of grain, a plow, a scythe, a blacksmith's hammer and anvil, and a gear wheel. . . . AN ALARM WRIST WATCH that thumps its wearer, with a small hammer, awakens him without disturbing others sleeping in the room. By rotating the frame containing the crystal, the alarm is set to any desired hour. When it goes off, its spring-actuated mechanism does not ring a bell, but releases a plunger that gently snaps against the wrist. An additional advantage pointed out by the inventor, Solomon Axelrod of New York City, is that the watch can be used for telling time in the dark. This is done by turning the alarm set until the alarm operates. Raised numerals can be felt with the fingers, and the alarm is then reset to the proper time. . . . If you have created a new, original, and ornamental design for a chair, a dress, or any other article of manufacture, you are entitled to what is called a "design patent." This runs for 3½ years, seven years, or 14 years, at your choice, and the fee is $10, $15, or $30, depending on the period of protection.

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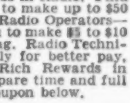

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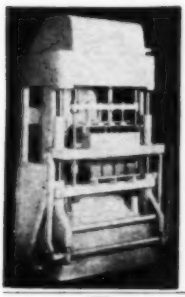

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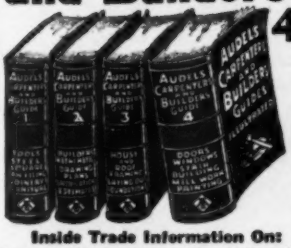

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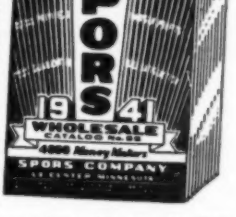

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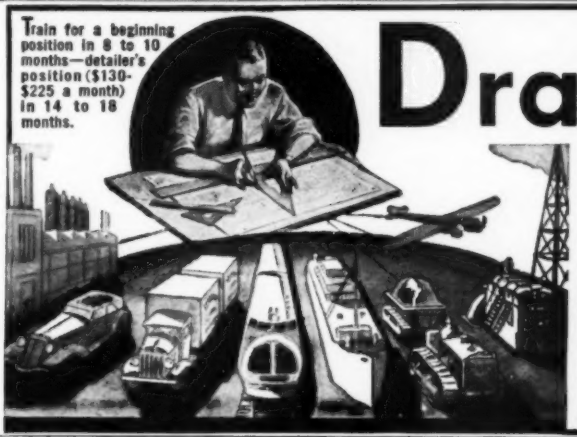

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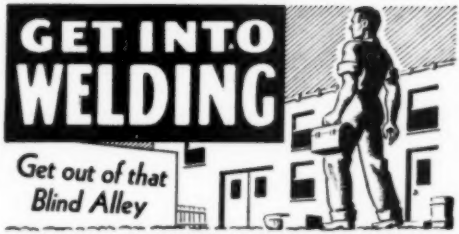

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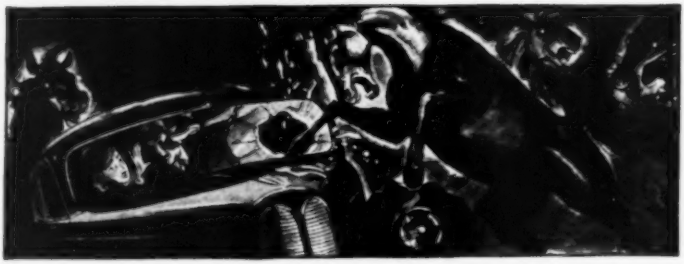

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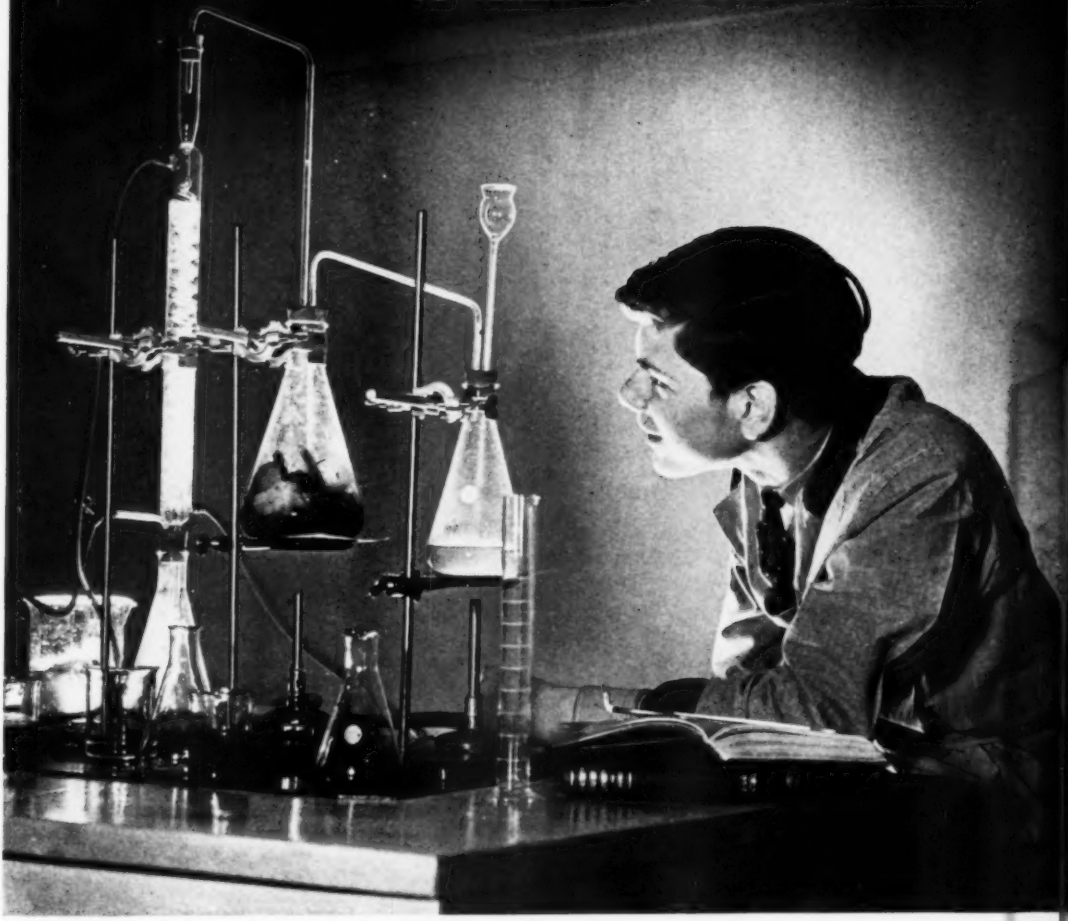
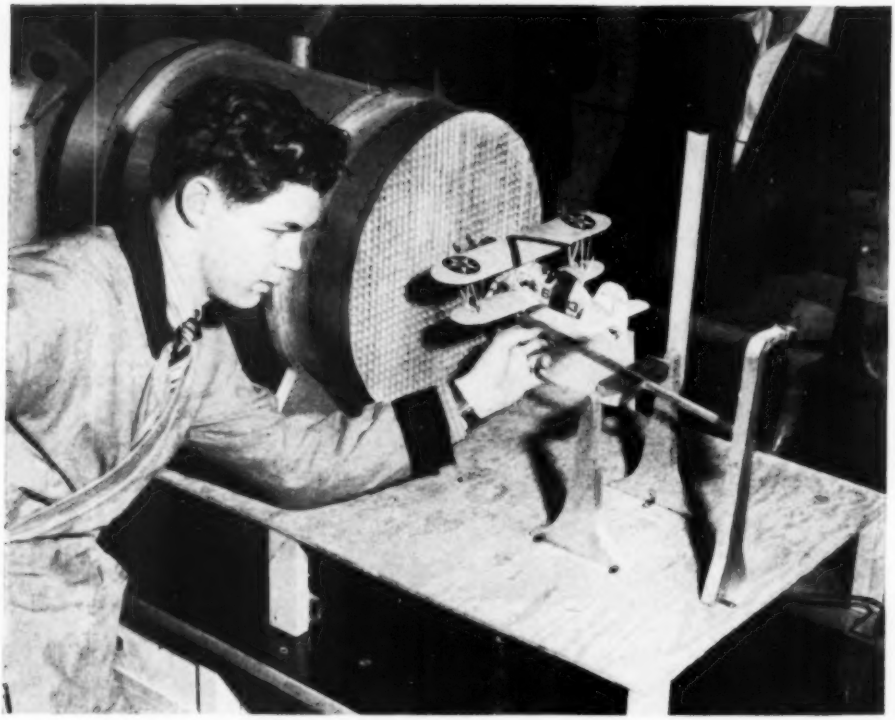
INDUSTRY GIVES A LABORATORY TO AMERICA'S YOUNG SCIENTISTS



YOUTHFUL IMAGINATION, an inexhaustible national resource, is being developed along scientific lines by the American Institute of the City of New York. This organization, chartered in 1828 and devoted throughout its existence to the promulgation of science and the encouragement of American industry, established its junior branch in 1928 and recently has intensified its efforts in this direction through the American Institute Laboratory at 310 Fifth Avenue, New York.

Its aim is to direct and utilize the imaginative faculties of youth which, since the founding of the institute, have been turning more and more toward science and mechanics. Under its wing are more than 730 juvenile science clubs, scattered throughout the United States, its possessions, and foreign countries. Some meet in high schools, some in settlement houses, and some are spontaneous youthful organizations with cellar or attic laboratories and club rooms. In the aggregate there are



Richard Walton working on his wind tunnel. The lift of the model plane is measured by a spring scale

more than 30,000 youthful club members.

They experiment with model airplanes, bacteria, telescopes, radio, tropical fish, light, sound, animal-breeding, and in numerous other fields. Their ambition is limited only by their own knowledge and the cost of equipment, and it was to obviate the latter difficulty to some degree that the American Institute Laboratory has been established with the coöperation of the International Business Machines Corporation, which gave the use of two floors of a New York City office building, and of the Westinghouse Electric & Manufacturing Company, which supplied the equipment.

There is room for thirty to work at a time, and the laboratory is used by three shifts daily. One uses it from 9 a.m. to noon; one from 2 p.m. to 6 p.m., and one from 6 p.m. to 9 p.m. It is open six days a week. Ordinarily, a student has the use of it for two periods a week.

Members of the junior activity clubs of the American Institute are eligible to use the laboratory. They are boys and girls from twelve to eighteen years old. Membership in their club, which pays dues of $2 a year to the institute, is the only requirement necessary except the ability of the student and the suitability of his project.

The student desirous of getting working space in the laboratory writes to the institute describing his project, its purpose, the equipment which will be necessary, and the time it will take. Allotments of space are made as it becomes available. The laboratory has projection microscopes, aquaria, a darkroom, drafting and drawing boards and equipment for their use, a wood-working shop with power sanders, lathe, drill presses, and other machinery, and departments fitted for special projects in radio, aviation, and the physics of sound.

There are tables fitted for glass-blowing, and other equipment with which students may manufacture some of the devices which may be necessary for the work they plan to do. A tool kit is issued to each student when he enters the laboratory, and at the end of his work period he replaces it, in condition to be used again immediately should a student in the next shift be engaged in the same kind of work.

There is a reference library, and students have access also to the library of the American Institute at its headquarters at 60 East

Forty-second Street. The laboratory also has an advisory board of scientists in various fields who will answer students' questions and give technical information.

Students are contributing constantly to the equipment of the laboratory. One is engaged in making a blueprinting machine, and another is working on a mimeographing outfit. Another is custodian of one of the stockrooms, working on his own project in his spare time.

Some of the budding scientists have domestic difficulties which interfere to some extent with their careers. One, whose mother is dead, has to leave a little early every day to get home in time to cook supper. So far as is known, supper never has been late, but an experiment he is conducting in hydroponics, to determine how onions thrive under varying conditions, suffered once for lack of sufficient attention.

Another fled to the laboratory as a sanctuary with his white mice. He had been breeding the animals to study the Mendelian characteristics of succeeding generations and about Christmas time last year, when he had reached the twelfth generation in his tests, his mother rebelled. Enough was enough, she said, and twelve generations of mice were altogether too many mice. She was exceedingly firm about it, too, and the young scientist had to lead an immediate exodus of his highly bred subjects. He found a temporary home for them with a neighbor until he gained admission to the laboratory. There the mice are housed in a cage built for just such experiments by one of the junior activity clubs of the institute in Malden, Mass.

The clubs all over the country are engaged in just such work as is going on at the laboratory, though generally without the equipment that is available there. The institute plans to establish other communal laboratories in centers where they may be used by several clubs. As far as possible, projects are undertaken at the New York laboratory with a view to helping clubs at a distance. Cultures, for instance, are being grown there in large quantities so that they may be sent to outlying clubs.

The American Institute has a Science Fair every year in the Education Hall at the American Museum of Natural History in New York, at which members of the affiliated clubs exhibit their handiwork. The institute sends its own technicians to aid in setting up the more elaborate exhibits. Leading scientists and educators are among the judges at the fair. Last year on the opening day the attendance was 7,222.

Airplane models naturally are among the more popular projects of club members, and Richard Walton, a youthful aeronautical engineer who won a prize at the Pittsburgh Science Fair, designed and manufactured a wind tunnel with which to test the model craft. Alan Goodman designed a seaplane bomber which carried torpedoes in its pontoons, reducing air resistance. It carried machine guns in the wings and a cannon on each side of the propeller.

Wallace Cloud, fourteen years old, a student at the Grover Cleveland High School, is working at the institute's Fifth Avenue laboratory on the distillation of household refuse. His experiments might put a high value on the garbage pail, as they indicate the possibility of extracting chemicals valuable both in medicine and for explosives.

Judges at the Science Fair have at their disposal $3,000 in prizes to be awarded for conspicuously good work. The Veterans' Wireless Operators' Association offers the Marconi Memorial Award Scholarship to institute members.

With the establishment of its laboratory in New York for boys and girls with a scientific bent, the American Institute feels that it has taken a long step forward in the program it undertook at the completion of its first hundred years for the training and development of the imagination of America's youth. When other such laboratories have been established, the youth organization of the institute will become a close-knit national training school.

William De Pasquale conducting experiments in the growth of plants in chemical solutions (hydroponics)

Pursuit Pilot

MAN OF THE MONTH:
Lieutenant Phil Cochran
flies a U. S. Army fighter

The Heart of a Fighter Plane Is the Pilot, and It Takes Three Years of Hard Work To Turn Out a Really Good One

By HICKMAN POWELL

THE six little planes became visible suddenly as a string of tiny dots, and almost immediately were circling around the field. They swung around in their traffic pattern at 1,000 feet. Then the leader dropped off, came down in a short, tight spiral, sideslipping all the way to lose altitude quickly. He set the fast Curtiss P-40 down as gently as a baby, and one after another the five other planes swooped down beside him. They bounced a bit, but out of that great military airport they had used only about enough space for a

At Mitchel Field, New York's fighter-plane nest, the pursuit pilot lives in this brick building . . .

. . . where he shares a comfortable two-room suite with one of his brother officers at the field

A private bath, an unusual luxury in the Army, is one of the amenities of life at Mitchel Hall . . .

. . . and another is the friendly social atmosphere, with an occasional off-duty game of cards

Typical meal: mushrooms on toast, cole slaw, pastry

Favorite topics of talk are flying, women, and flying

Before taking off, pilots get their flying togs from individual lockers in the flight building . . .

. . . and huddle around the blackboard while their flight commander explains what they are about to do

Wearing their parachute packs, they file out of the building to planes waiting on the field . . .

. . . where the leader gives last-minute directions for the various maneuvers they are going to perform

After a training ship, flying one of these P-40's is like changing from a saddle horse to a bucking broncho

cabbage patch. And it was as quick and flashy as a flight of swallows swirling around your house and diving down the chimney.

"That ought to be Phil Cochran now," said the public relations officer. "He is due any minute now, and that looks like his group."

This was at Mitchel Field, Long Island, which the Army Air Corps had recently changed from a bomber base into a fighter-plane field for the protection of New York City. I had come out there that morning and said I wanted to talk to pursuit pilots, especially to some of the kids who had recently been flying cadets at Kelly Field. If it takes two years to make a military pilot, and three years to make a good one, as all the experts say, then there must be a lot these boys can tell about their job. Stuff we all want to know; for, after all, these lads are the American version of the Hurricane and Spitfire boys who so recently have rescued civilization.

Now the six planes came taxiing across the field toward the hangar, swirling up a great cloud of dust behind.

"Cochran is the man for you to talk to, all right," said the officer. "He's been breaking in a bunch of the kids. They call him Cocker."

First Lieutenant Philip G. Cochran, flight leader in the 33rd Pursuit Squadron, when he had unzipped his heavy flying suit of leather and lambskin, turned out to be a pink-faced little youngster with dark, curly hair, a wide smile, and vast enthusiasm for his job. He came from Erie, Pa., and was graduated from Ohio State University in 1935. He has been in the Air Corps five years, and I was surprised to learn he was 31 years old, which is above the average. That was because, what with the depression, it took him six years to get his college degree. He worked his way through, by singing in a dance band.

After he had attained that seemingly impossible college degree, Cochran felt ready to tackle something else impossible, so he put in for appointment as a flying cadet. He told me later he never felt so futile or silly in his life as when he went in for the physical exam. Before him was an intercollegiate wrestling champion and behind him was a Big Ten football star, and he felt very insignificant beside their manly torsos. But the wrestler's blood pressure was too high and the footballer was muscle-bound. The crooner got through.

Phil Cochran would be horrified that I am writing about him thus personally, but it has to be done. You can't separate fighter flying from the pilot's personality. In the late stage at Kelly Field they pick the boys out for specialties. Sound, careful pilots go with the Regular Army for observation work. The brainy boys with executive ability and a flair for navigation and technical matters are picked for bombardment, to drive the big freight trains. To be a pursuit pilot you've got to be a motor-cycle rider or an outboard motor-boat racer at heart. You've got to be scrappy, and you've got to be small.

Phil Cochran stands five feet seven and weighs 147 pounds. That's just what he weighed when he enlisted. He's kept it by playing a lot of squash when on the ground. The man who is sluggish will black out quicker than one who gets a lot of exercise. Blacking out is what happens when, in a quick turn, centrifugal force drives the blood from your head. You see red, then gray, and then you are unconscious for a moment.

The pilot who blacks out last has an advantage, but there's nothing wrong about blacking out. In an ordinary morning's routine rat race behind Phil Cochran the boys go black four or five times. If you don't do it you aren't flying the plane right, for the best plane in the world is second-rate if it isn't delivering every ounce of performance. That's where mental attitude and personality come in. The boys say Cocker is good because he drives them every moment in the air. When he takes a flight on a mission, he never goes right there and back. At any instant, he is likely to pick out a target and dive for it; and you've got to be right there in the formation with him. They say Cocker always takes a flight off and lands it as if they were using a small emergency field in the midst of battle.

The youngsters working with Cochran think they are very lucky to learn from a man with such aggressive flying habits, for fighter flying is largely a state of mind—straining always at the limits of speed, maneuver, and precision. Having learned such habits, they will be able to pass them on to other boys who will be pouring into the Air Corps. And it is this matter of attitude, of never taking it easy, which makes the difference between a fighting squadron and a collection of aviators.

The 33rd Pursuit Squadron's latest batch of new officers joined it in September. They had just received their wings and commissions, after three months (65 hours) of flying in primary trainers with civilian instructors, three months (70 hours) at Randolph Field in basic trainers, and three months (another 70 hours) at Kelly Field in advanced trainers. They had had an easier time than prewar classes, for the Corps is not eliminating so many nowadays, but they were well-trained flyers who had

been through a stiff course. Now they were at the most difficult point, the transition to a tactical airplane.

Lieutenant Cochran took those assigned to him and set each of them in the cockpit of a P-40, let him sit there for an hour just getting familiar with it. The new man was fresh from flying a fine, sensible airplane, of 450 horsepower, less than 200 m.p.h. maximum speed. Now he was going to fly one of the newest of tactical planes, the one known to the British as the Tomahawk. It had a 1,000-horsepower liquid-cooled Allison engine, would do more than 300 miles an hour. It was a further development of the plane which made that famous dive last year, at 575 miles an hour. There was no seat for an instructor. The new man had to fly it alone.

The big hurdle was psychological. The most important thing about flying a pursuit plane is to have perfect confidence that you are its master. Cochran took the boys one by one and sold them the idea that they could fly the P-40. It was like talking to a man who has learned to ride a gentle saddle horse, and persuading him that he was ready to tackle a bucking broncho.

Then the first flight. Once the new man was up in the plane, his problem was how to get down, and he probably felt out the plane for a half hour before trying that. There were a number of things to try out. For instance, he had to gain a lot of altitude before he could open up the throttle wide; for the Allison is built to fly best at high altitudes; if you open her up at the atmospheric pressure of ground level, you'll exceed manifold pressure; she'll get hot and quit on you. Then there was the variable-

Pilots' Wall Map Shows Course and Flying Distance

HOW far away is the objective? What is the course? For pilots taking off from Mitchel Field, these questions are answered by the wall map at the left. Out of a hole at the point representing the field the flyer draws a tape attached to a spring reel. By placing the end on his destination, he can read on the tape the distance to be flown. At the same time, the direction can be read on a divided circle drawn around the opening; by noting the point where the tape crosses the circumference, the pilot knows his course. The map covers the region within a radius of several hundred miles from the field—the country over which the pursuit pilots make training flights.

pitch prop control to try out; the Allison runs at constant speed; you use increased power by taking a bigger bite of air with the propeller. After gradually putting her into a stall a couple of times, to try out minimum gliding speed, he took the bit in his teeth and brought her down.

Three flights the first day were the transition pilot's quota. After ten hours of transition flying, he was ready to try some simple maneuvers in formation. No matter how good you are to begin with, it takes 50 hours flying one of these planes before you can throw it around.

The first thing about formation flying is to come in close, and stay put. The first two that went up with Phil Cochran came close, but not close enough. He put up his index finger and waggled it in a come-hither gesture. They were close enough to see the finger waggle, but he wanted them a lot closer. That takes nerve and confidence at pursuit-plane speed. But before this year is over each of these boys will be flying in a squadron formation with planes both above and below him, with no more than a few feet clearance. At times, he won't be able to see the plane below him, of course. But he will know right where it is, because it is precisely aligned with the planes on either side.

These three planes had two-way voice radio, of course, but Cochran didn't use it much. In battle, radio may go out of commission. Also, if you are getting ready to attack a bomber which hasn't seen you yet, you don't want to discuss it on the air. Right from the start you learn to rely on signals, and on following the leader.

Formerly, pursuit pilots signaled by stick-

Lufberry Circle—a Basic Defense Fighter Formation

WHEN a flight of fighters finds itself outnumbered by enemy pursuit ships, it goes into the Lufberry circle. At six ship lengths apart, the circle is about 400 feet in diameter, and at 200 miles an hour the planes make more than 13 revolutions a minute. Each pilot protects the tail of the one ahead, so that an enemy cannot get into effective range without being riddled. By moving the circle in upward spirals, the flight can gain altitude; by taking the circle sideways, it can ease toward a friendly base. Originated in the World War and named after the famous American ace, the Lufberry circle is still a fundamental defense formation for fighter planes.

ing an arm out of the cockpit, in a sort of semaphore. But cockpits are closed now; and, anyway, the man who stuck his arm out of a plane at 300 m.p.h. would wish he hadn't. Signaling now is done by the leader's plane itself, and there are three basic signals:

Tail wiggle (a horizontal movement, done with the rudders). In V formation, this means "Get into string." In string formation it means "Go into V."

Wobbling wings (done with ailerons). This means "Build up to larger formation."

Up-and-down tail hop (down with the stick). This means "Break down to the next smaller unit and follow the leader." This also is the signal for landing, if the leader lands.

In the 8th Pursuit Group they use another signal, the *quick wing wobble*, practically a vibration. In string formation, this means "Make company front." It also means "Attention, watch what I do, be ready."

They've been telling a story of what happened in a recent three-ship training flight in Texas. The leader's engine began going bad, and he jerked the stick back and forth to try to jolt the carburetor into action. The trick didn't work. The engine went dead. So he picked a spot and landed. Fortunately he was safe. Then he looked around to see what had become of his companions. They were sitting there in the farmer's field beside him. They had seen his tail hop and followed him down. That is what is called air discipline. The story does not tell what the two trainees were thinking as they followed the dead engine.

You will notice that none of these signals has anything to do with turns, banking, loops, and other things most of us think of as combat maneuvers. For these there are no signals. They are merely a matter of following the leader. If you think a girl is good when she follows her partner on the dance floor, then consider the pursuit flyer, who has to do the same thing with precision multiplied a thousandfold, in a plane going five miles a minute. His attention is glued on the leader, until he follows him automatically, with split-second accuracy. In a very real sense, the leader flies his whole formation.

After Cochran had got his two pupils in close, he made a quick turn to the left and lost them. Sure enough, the man at the right (the outside) fell behind. The inside man, at the left, dropped down. What they must learn was to go right around with him, sticking right in their places. They tried again, and this time he used the radio a little. "Come on, give more gun," he said to the man at his right, who had to travel farther, being on the outside. This time he got it, held himself right there by the leader's wing, as they went around in an almost vertical bank.

When a company of foot soldiers turns column right, the man at the right of each squad pivots, practically marking time at the turn. But airplanes can't stop that way, and when they turn, they all have to start at practically the same instant; they don't go around a corner. Theirs is a fluid maneuver, and they are able to equalize the differences between inside and outside turns by using the third dimension, and also by crisscrossing their courses.

Formerly when three planes were flying a turn, they crossed over in this same fashion, to equalize the distances. But today's planes maneuver so well that when flying in threes they no longer cross.

The boys learned various special things at this period. They had to work on cross-country navigation, for in a fast plane you are likely to get lost. They worked at night flying. They made a maintenance flight to a strange base, away from home mechanics, learning the routine of taking care of their planes. There were many special tricks they had to learn about flying these fast ships.

For instance, putting down the retractable landing gear. To lower the wheels you have to cut down to 170 miles per hour. But you need to maintain power, because the mere lowering of the wheels slows the plane down 50 miles per hour. So the leader dives and pulls up, to lose speed without reducing the throttle. Then the wheels go down, and another dive picks up speed again, while the pilots check up on each other's wheels, nodding to each other through the glass hoods covering their cockpits.

As the new men began to be able to throw their planes around in formation flying, they would go up in larger groups. Every day, going up on the regular morning flight, they would first go into string and then have a rat race. A rat race is something few of us will ever see, for like a dog fight it goes on at high invisible altitudes, and is too fast for effective photography. It is, really, a simple game of "follow the leader" in fighter planes. The leader does everything he can think of—Immelmanns, loops, snap rolls, and turns, always turns, tighter and tighter. To the fighter pilot the turn is what the left hand is to the boxer. In a dog fight the man will win who can turn inside the other.

After rat-racing until everyone was tired, they would practice the Lufberry circle. Invented during the World War, this maneuver is the great, fundamental defense formation of pursuit planes. If a flight of fighters finds itself hopelessly outnumbered by enemy pursuit ships, it goes into the defensive circle. *(Continued on page 220)*

How Much Exercise Do We Need?

By DONALD A. LAIRD

Illustrations by Ellison Hoover

Should sedentary workers take a heavy workout once a week?

No A daily walk of about one hour gives the office worker an adequate amount of exercise. An occasional vigorous workout is not as desirable as the regular daily exercise which does not bring on exhaustion. A strenuous week-end of hiking, golf, dancing, may do more harm than good. A little moderate exercise every day is the ideal, especially if the exercise is in the outdoors.

Are setting-up exercises as good for adults as games?

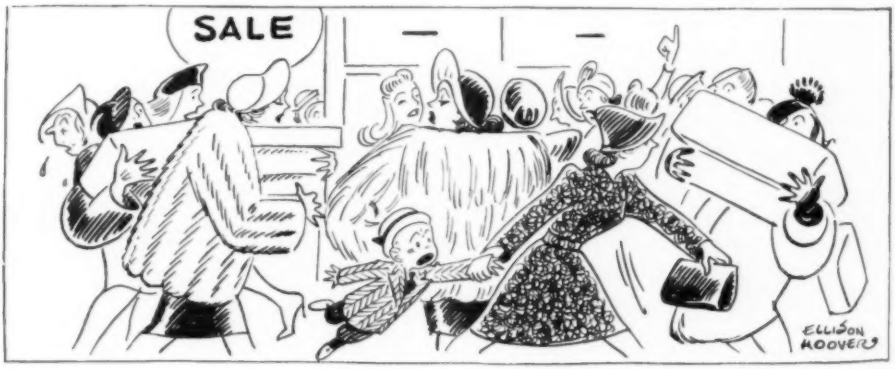
No Speed and endurance stunts are definitely unwise for adults who are not professional athletes. Games and dancing are ideal forms of adult exercise, though the tendency is often to overdo these. Games are as good for mind as they are for body. Setting-up and bedroom exercises have one advantage—regularity.

Is exercise at bedtime good for sleep?

No Exercises in the morning may be good to help wake up, but exercises at bedtime tend to interfere with going to sleep and with sound sleep. Relaxation before going to bed is better than exercise.

Is a day of shopping good exercise?

Yes A day spent in shopping involves about eight miles of walking through stores and streets. It would be better exercise, of course, if this distance was walked in the open air. No wonder shopping is tiring!



Is exercise itself a good way to reduce?

No Water is the chief loss in weight from exercise; only about 1/10 of the weight loss after exercise is due to disappearance of fat. The amount of foods eaten must also be cut down to reduce weight. The exercise alone may produce so much appetite that more food is eaten, and weight may actually be gained. Moderate exercise and moderate eating is the best combination.

Will a dish of ice cream support a half hour of sawing wood?

Yes A doughnut will furnish enough calories for a little more than an hour of old-fashioned sweeping. Nearly two hours of knitting will be supported by a couple of waffles. Two scoops of ice cream will take care of about a half-hour of sawing wood. An orange will support typewriting for the better part of an hour. To exercise off a Thanksgiving dinner quickly, one needs to run fast for three hours. A cocktail will supply the energy for an hour of dishwashing.

Has electricity increased our need for exercise?

Yes Electrical appliances have made work much lighter and authorities believe that people should now give more attention to the exercise of their large muscles — shoulders, thighs, abdomen—which are relatively unused.

Is housework a good form of exercise?

Yes The average housekeeper gets all the exercise she needs in her varied daily tasks. Many housewives, in fact, get more exercise than is needed. The exercise of housework could be made better only if it could be done in the open air and sun. If the average housewife puts on weight, it is not because she exercises too little, but because she eats too much.

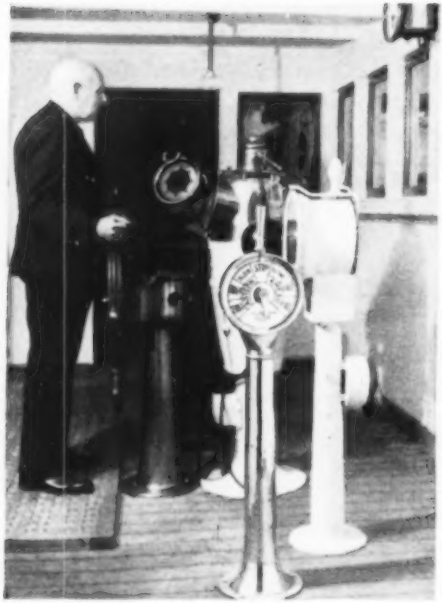
Are there foods or pills which will take the place of exercise?

No Almost any food will support exercise, but the carbohydrate foods—such as sugar and starches—give quickest support. No food or pill, however, will massage the body the way exercising does. This massage is important for squeezing waste products out of muscles and helping the tone of the blood vessels. The automatic massage given by exercise helps clear stagnant blood out of the veins. These are some of the reasons why hospital patients are given a thorough massage and kneading—even to their toes and fingers—every day.

Does exercise after meals harm digestion?

No Reasonable amounts of exercise after a meal do not influence digestion, experimenters at the University of Wisconsin have found. Actually, gentle exercise before or after meals appears to help digestion. Abdominal exercise a short time after a meal has been found to speed the passage of food through the intestines.

Exhibit Allows Landlubbers To "Navigate" a Ship

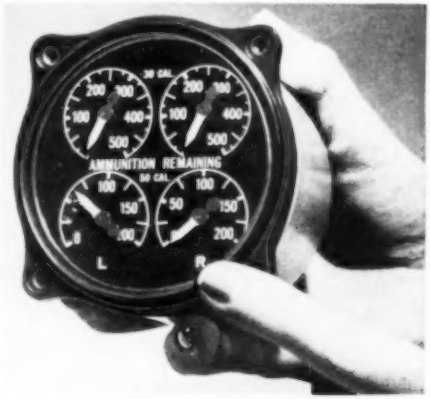


Dry-land bridge and chart room have all the instruments for guiding a vessel. At right, girl learns to find position with a sextant

A FULLY EQUIPPED bridge and chart house, part of a nautical exhibit just installed in The Franklin Institute at Philadelphia, enables any visitor to go through the motions of guiding a merchantman or man-o'-war. A near-by wall chart, illustrated with diagrams, explains how to calculate latitude and longitude by "shooting the sun." Anyone with a speaking acquaintance with mathematics can master the simple directions in fifteen minutes, it is said, and test his skill by actually working out a position himself. Other exhibits include pictorial explanations of the language of the sea, so that a landlubber may learn what is meant by such nautical terms as "On the port quarter" and "Abaft the starboard beam."

Dials Tell the Fighting Pilot How Many Bullets Are Left

FOUR little dials tell a life-or-death story for pilots of military aircraft, in an Ammunition Remaining indicator developed by General Electric engineers. No matter where the guns may be placed on a plane, the instrument tells the number of bullets left in each, so that a pilot may know whether to pursue an enemy craft or break off an engagement. In the illustration, it indicates that virtually all of the 1,000 rounds for the two .30 caliber guns have been fired; one .50 caliber gun still holds more than 60 of its original loading of 200 shots, while the other is empty. Electrical impulses operate the indicator.



Four dials tell whether to fight on or cut for home

TRAILER ZOO

An eagle whittled from white pine and painted by Luther Hinkle . . .

. . . who is seen at the right roughing out a panda in a block of wood

ANIMALS of all parts of the world are represented in a trailer zoo created by Luther Hinkle, a steel worker of Chesterton, Ind. In 24 miniature natural habitat groups, there are nearly 70 animals, reptiles, and birds, all whittled to scale from white pine and realistically painted. There are even tiny wooden eggs in the eagle's nest. Four hundred hours of whittling went into the displays. Week-ends, Hinkle drives his rolling zoo to mid-west towns and villages where children flock to see the novel exhibit.

The panda takes form under Hinkle's blade. It takes him about six hours to cut and paint such a figure

In the trailer zoo at the left, Hinkle exhibits his 24 animal groups to children in near-by villages and towns for a small fee

Infantry's New Weapons Give Fire Power and Punch

By JOHN WATSON

ONE DAY in 1941 Dick Brown, average young American, sound of body, alert of mind, answers the call of his country to become part of its combat manpower, and is assigned to the infantry. Dick's father, let us say, was an infantryman 24 years ago, in that other great call to arms, but Richard, Sr., would find it difficult to recognize the infantry into which his son is inducted. For the modern infantry is no more like that of World War days than the rhumba is like the 1917 shimmy dance.

In the 1941 infantry, Dick may become a rifleman, in which case he will use a Garand semiautomatic rifle instead of the Springfield .30 with which his father fought. Or he may become part of an automatic-rifle squad, whose weapon is a .30 caliber Browning automatic rifle which can be fired with or without a mount.

Or he may become a member of a weapons platoon and be trained in the use of an air-cooled .30 caliber Browning light machine gun, and a 60-mm. mortar, which looks like a toy—a toy that can lob three and a half pounds of explosive death to a maximum useful range of 1,900 yards.

Or Dick may become a member of a heavy-weapons company which uses a .30 caliber Browning heavy machine gun, water-cooled, and an 81-mm. mortar that throws a light seven-pound explosive shell to a maximum useful range of 2,000 yards, a medium ten-pound shell somewhat less, or a heavy shell to a maximum useful range of 1,500 yards; and a .50 caliber antitank machine gun.

And finally Dick may be assigned to a modern antitank company. In this case he will be trained to serve a 37-mm. antitank gun, a comparatively new fieldpiece that fires a high-explosive shell with an armor-piercing capacity of one and a half inches of armor plate at 1,000 yards.

As an infantryman in any special capacity, such, for example, as a messenger attached to a platoon, or as part of an automatic-rifle squad or a machine-gun section, and so on, Dick will wear as a side arm a .45 caliber Colt automatic pistol. As a rifleman his only side arm will be the bayonet, for the thrust of cold steel in individual com-

A U. S. Army rifleman with full field equipment, including the Garand rifle . . .

. . . cartridge belt, canteen, half shelter tent, intrenching tool, first-aid pouch, helmet, bayonet

His whole load weighs only 57 pounds, 33 pounds less than was carried by our World War soldier

A new infantry arm is the 37-mm. anti-tank gun, which can pierce 1½ inches of armor at 1,000 yards

•

Also meant for tanks is this .50 caliber air-cooled machine gun (nine-man crew)

bat remains, despite all modern developments, a basic form of infantry training.

Hand grenades also constitute a part of Dick's basic training as an infantryman. In the U. S. Army grenades are shaped somewhat like small pineapples. If Dick has ever played football, throwing grenades will be easy. When Richard, Sr., was taught to throw grenades he held his arm stiff a little in back of his body and threw the grenade in a stiff-arm overhead motion. Dick cocks his hand at his shoulder and throws as if he were throwing a football.

All infantrymen, no matter to what special unit they eventually are assigned, are trained in the use of the rifle, bayonet, and grenade. And under the new training set-up, just now being established, all infantrymen will receive general training in most of the other infantry weapons as well, as a prelude to extensive, specialized training in the units to which they are finally attached.

The new training set-up is based on the establishment of so-called replacement centers for all branches of the Army. The infantry replacement centers have been constructed at Camp Roberts, San Miguel, Calif.; Camp Wolters, Mineral Wells, Tex.; Camp Wheeler, Macon, Ga.; and Camp Croft, Spartanburg, S. C.

Under this new plan, Dick, when he is inducted, is sent to one of these centers. There he receives 13 weeks of basic infantry training. These centers actually become vast training reservoirs to which division or regimental commanders send requisitions for men to fill vacancies in their outfits. At the end of his 13 weeks, Dick joins the tactical unit to which he is assigned, already trained in the fundamentals of a soldier and ready for more advanced training. When the new plan gets into full operation it will resemble an automobile assembly line applied to manpower.

The first combat unit with which Dick becomes associated is the squad—and here begins the difference between the composition of the modern infantry and that of 1917. When Richard, Sr., became a fighting man the rifle squad consisted of eight men. They formed in double rank of fours and the man on the right of the front rank was the corporal, the squad commander.

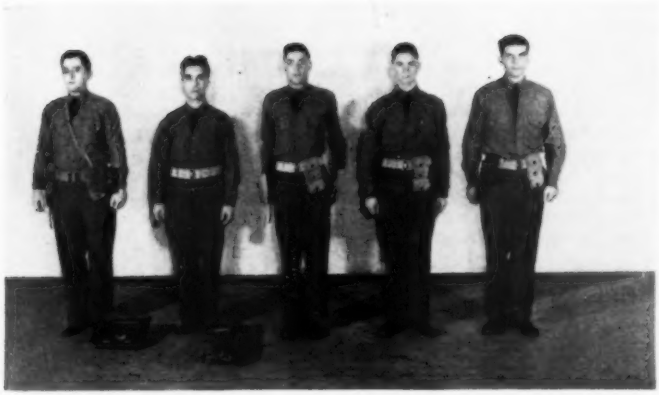
The modern rifle squad consists of 12 men. Ten are privates, one is a corporal—now second in command—and the leader is a sergeant. Instead of the double formation the men line up in single rank, with the sergeant at the extreme right, the corporal at the extreme left.

The modern infantry platoon is composed of three rifle squads, an automatic-rifle squad, and a platoon headquarters group. The automatic-rifle squad consists of eight

60-MM. MORTAR looks like a toy, but it lobs 3½ pounds of explosive to a range of 1,900 yards

81-MM. MORTAR fires shells of three different weights, with ranges of 1,500 to 2,000 yards

.30 CALIBER MACHINE GUN, water-cooled. Tubes lead cooling liquid to and from the jacket



New Guns and the Men Behind Them: Three of the Special Weapons of the Streamlined U. S. Infantry, with their Trained Crews.

A five-man squad handles the 60-mm. mortar. It consists of a corporal (who is the gunner), an assistant gunner, and three ammunition carriers

It takes nine men to fight the 81-mm. mortar: corporal, gunner, assistant gunner, five ammunition carriers, and a chauffeur. Mortars and machine guns have motor carriers and automatic rifles to fight off planes

The same set-up is used in the nine-man squad of the .30 caliber machine gun, and of the .50 caliber machine gun (page 65). Each company has a heavy-weapons platoon, each battalion a weapons company

men: a squad leader, an assistant, two riflemen, two assistant riflemen, and two ammunition carriers. The platoon headquarters is composed of a second lieutenant, commanding the platoon, two sergeants, two messengers, and five privates. Basically there are 53 men and one officer in a modern platoon.

It is only a rifle squad that has a full strength of 12 men. The various weapons squads, such as the automatic-rifle squad, are composed of only five to nine men.

These squads break down as follows: .30 caliber light machine gun, five men—corporal, gunner, assistant gunner, and two ammunition bearers; 60-mm. mortar, five men—corporal, who is also the gunner, an assistant gunner, and three ammunition carriers; .30 caliber heavy machine gun, nine men—corporal, gunner, assistant gunner, five ammunition carriers, and a chauffeur; 81-mm. mortar, nine men—same set-up as

THE 1941 DOUGHBOY HAS MORE THAN ONE

AUTOMATIC RIFLE. Fired with or without a mount. An eight-man squad serves two of them

BAYONET. The only side arm carried by riflemen. Cold steel still counts in hand-to-hand fighting

GARAND RIFLE. Basic weapon of U. S. infantry. Its rapid action gives tremendous fire power

AUTOMATIC PISTOL. The .45 caliber Colt is worn by messengers and members of weapons squads

heavy machine gun; 37-mm. antitank gun, five men; .50 caliber machine gun, nine men.

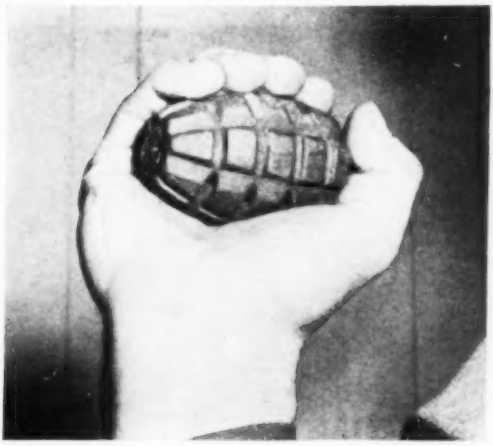
Advancing now from a platoon to a company we find that the 1941 infantry company is composed of three rifle platoons and —to the bewilderment of Richard, Sr.—a weapons platoon. The weapons platoon is to a company what the automatic-rifle squad is to a platoon.

The weapons platoon comprises a command group, one 60-mm. mortar squad, and one .30 caliber light machine-gun squad. The mortar squad has three mortars, the machine-gun squad has two machine guns. The mortars are used for blasting out enemy machine-gun nests, the light machine gun for the close support of small rifle units by flanking fire. Both mortars and machine guns are moved in motor carriers, and each of the sections carries an automatic rifle for antiaircraft fire. There are messengers attached to rifle and weapons sections.

STRING TO HIS BOW

HAND GRENADE. It resembles the "pineapple" of the World War, but throwing style has changed

Instead of being flung with a stiff-arm motion, it is heaved from the shoulder like a football



The modern company, which includes a headquarters group as well as the rifle and weapons platoons, is composed of 217 men and six officers, as compared with 250 men of the old company. It is designed for flexibility, speed, mobility, and striking power, and the same design extends from the company into the modern infantry battalion. Just as an infantry company has a weapons platoon, so an infantry battalion has a weapons company. There are three rifle companies in a modern battalion and one heavy-weapons company.

The weapons company is equipped with .30 heavy machine guns, .50 machine guns, and 81-mm. mortars. All these weapons are also carried by motor transport. A sure way to tell whether an infantryman is in a rifle company or a weapons company is by the letters with which the companies are designated. Every fourth letter indicates a weapons company. For example, Companies A, B, and C of a battalion are rifle companies; Company D is a weapons company.

In the modern infantry there are now 15 companies to a regiment, rather than 14 as when Richard, Sr., was a soldier. The extra company is an antitank company, armed with 37-mm. antitank guns. That is, there are three battalions of four companies each to a regiment. That makes 12 companies. A headquarters company and a service company make 14, and the antitank company completes the regiment formation. Two hundred and forty-four vehicles—sedans, motor cycles, trucks, and trailers—form the motorized equipment for the modern infantry regiment.

The Regular Army division is now triangular, rather than square as it was when Richard, Sr., was in the A.E.F. That is, there are three regiments in each of the nine Regular Army divisions, instead of four regiments to a division. The reason for this once again is the insistence on speed, mobility, and striking power. The 18 National Guard divisions, however, still retain the old four-regiment composition.

Simplicity has been extended to close-order formations and drill for the new infantry rifle squads, platoons, and companies. There are no more commands such as

"Squads right!" "Squads left!" or the more oblique movements, "On right into line!" and so forth. The squads now line up in single rank, one behind the other until they are three deep. The command to bring them into column marching order is "Right face! Shoulder arms! Forward march!" or "Left face" and so on. It sometimes took two weeks to teach a squad the simplest of the old-time commands. Now a squad can be taught the fundamentals of drill in one tenth the time.

The differences between the infantry which Richard, Sr., knew and that into which Dick is inducted extend even to clothing and the weight of the pack a man carries. Richard, Sr., wore a choke-collar coat and his lower legs were incased in spiral leggings that often were wrapped so tightly that a man would keel over on the march from lack of circulation. (They even killed the hair roots on the calves of the legs.) Richard, Sr., lugged 90 pounds of equipment on the march.

Dick wears a comfortable, attractive lapel coat and long trousers. When he is in the field the trousers are tucked into canvas leggings. His equipment weighs 57 pounds, 33 less than his father carried, and yet includes all the necessary articles: a blanket, tent pole, tent pegs, half of a shelter tent (the other half is carried by his tent partner), tent rope, extra underwear, socks and handkerchief, toilet articles, mess gear, rations, first-aid pouch, ammunition belt, helmet, rifle, canteen, bayonet, and—this is very important in modern combat—an intrenching tool, which may be a small shovel, a small ax, or a pick-mattock. His corporal or sergeant also will carry wire clippers.

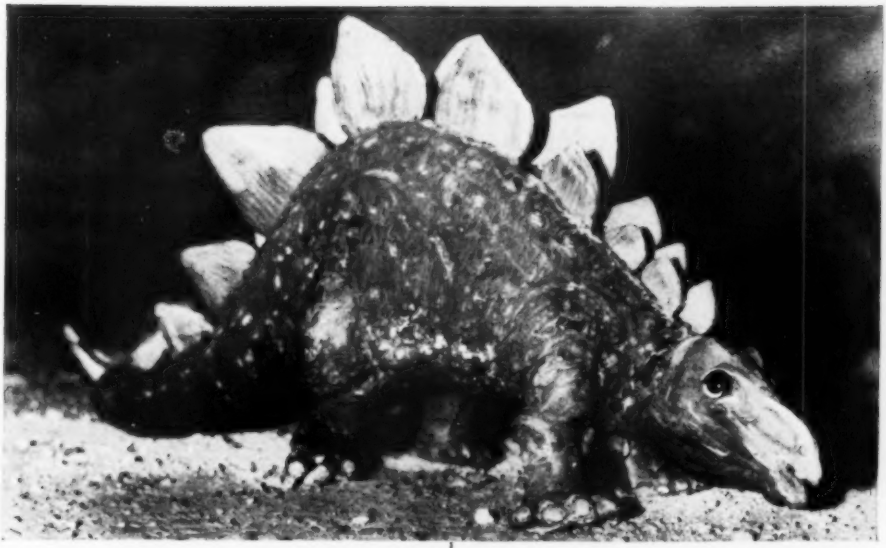
Dick's pack is so ingeniously constructed that when he goes into action he jerks a strap and the equipment he will not need drops to the ground, leaving him only 18 pounds to carry. Besides his weapons and ammunition belt, carrying ten clips of eight rounds each of cartridges, this includes his intrenching tool, mess gear, and rations.

After Dick has learned the fundamentals, he still has far to go. He must learn the art of camouflage. He must learn to read maps, to travel by compass, or to use his watch and the sun in place of a compass, and to orient himself at night by means of the stars. He is taught to recognize the whine or shriek of an artillery shell and to sense the proximity of the burst. He is taught to identify the fire of small arms and to locate the origin of fire of small arms from the sound of the discharge instead of, incorrectly, the crack that bullets make when they are already in flight.

He is taught how to use his intrenching tools to scoop out a hollow for himself in the earth. He is taught how to advance in combat, by rushing forward and then throwing himself to the ground, taking advantage of the shape and color of the ground and background. He is taught how to advance behind tanks, how to fight in a clump of woods, how to move cautiously through a village. For modern warfare is not the trench warfare that Richard, Sr., knew. Modern warfare has returned to the classic conception. It is warfare in the open, in the field, in woods, in villages; quick, short thrusts, and when the final surge forward comes Dick is virtually on his own, and therefore he must be trained not only in discipline but also in initiative.

For when the big guns have spoken, the tanks have rumbled and spat fire, the planes have dumped their bombs, the machine guns have chattered, and the mortars have curved their loads of destruction against enemy emplacements, it is Dick Brown, modern rifleman, who places the final stamp of victory on a military operation.

Each of the first three ranks of this platoon is a squad of riflemen. Automatic-rifle squad is behind



Stegosaurus, with armor plates along its back, and two brains, of which the better was above its tail

Animated Models Tell the Story of Prehistoric Times

FIFTY-SEVEN models of prehistoric beasts, many of them ingeniously animated, occupy a 125-foot-long exhibit built by Lou Bedford, of Hollywood, Calif. Combining his skill, derived from 26 years of experience as creator of special movie effects, with information obtained from leading museums, he molded the lifelike animals from a pliable elastic compound. Air-motivated dinosaurs breathe and snort, and one, operated by motor-driven wires, tosses about a serpent in its jaws, amid scenery in which mud bubbles and geysers spout.

Invisible ultra-violet light and three other lighting systems give dramatic effect to metallic paints used on animals, settings, and cloud backgrounds. Each 12½-foot display represents one of ten prehistoric eras.

Bedford arranges models of Dimetrodon, which once lived in Texas

Air-motivated duck-billed dinosaurs (Trachodon) breathe and move

Frigate *Constitution* rests on the ways, with one of her masts, still unstepped, lying beside her in the model shipyard

Model Shipyard Shows Warships of the Past

To show how warships of the past were built, an accurate model of an eighteenth-century shipyard has been completed by The Franklin Institute, in Philadelphia. On the building ways, in different stages of completion, so that their construction can be studied, are the frigates *Constitution* and *Hancock*. Inch-tall figures represent shipwrights and shipsmiths at work, and the model includes a counting house, drafting room, molding lofts, and rigging lofts. Every step in shipbuilding at that period is depicted exactly to scale.

Model workmen are making the "knees" of a frigate, with the shipyard's counting house and drafting room in the background

Question Bee

This time the quiz is about medicine. If you want to find out how much you know, turn to page 220.

1 Nitrous oxide is used as an *(a)* antiseptic *(b)* astringent *(c)* anesthetic *(d)* antitoxin.

2 Red corpuscles of the blood *(a)* transmit nervous impulses *(b)* carry oxygen *(c)* devour germs.

3 One of the greatest of recent medical discoveries was the drug called *(a)* tung oil *(b)* red squill *(c)* ethylene glycol *(d)* sulfanilamide.

4 Whether an individual grows to dwarf, medium, or giant size depends upon his *(a)* hormones *(b)* enzymes *(c)* adenoids.

5 Tincture of iodine consists of solid iodine dissolved in *(a)* water *(b)* alcohol *(c)* ether *(d)* formaldehyde.

6 Your pericardium is around your *(a)* neck *(b)* waistline *(c)* heart.

7 Cases of myopia are treated by prescribing *(a)* cyanide of potassium *(b)* hydrotherapy *(c)* liver extract *(d)* eyeglasses.

8 Hay fever often is caused by *(a)* parasites in meat *(b)* the bite of certain spiders *(c)* ragweed pollen *(d)* exposure to cold drafts.

9 Trypanosomes are *(a)* units of heredity *(b)* operations on the head *(c)* spots before the eyes *(d)* parasites such as cause sleeping sickness.

10 Chlorination is used to *(a)* correct acidosis *(b)* sterilize drinking water *(c)* cure baldness.

On its initial haul, crowds flocked at every stop to view the huge new Santa Fe Diesel freighter

Giant Locomotive

IS FIRST ALL-DIESEL FREIGHT ENGINE

By Schuyler Van Duyne

SPEEDING as no freight train ever did before across the western two thirds of the continent, the world's first Diesel-powered freight locomotive hauling six special cars and 58 loaded freight cars has just signalized the first all-around Dieselization of an American railroad. To boot, it broke speed and economy records, proved that a single locomotive could do the work of nine of the steam type on a long run, and aroused the interest of the nation's shippers in this latest step toward "streamlining the railroads."

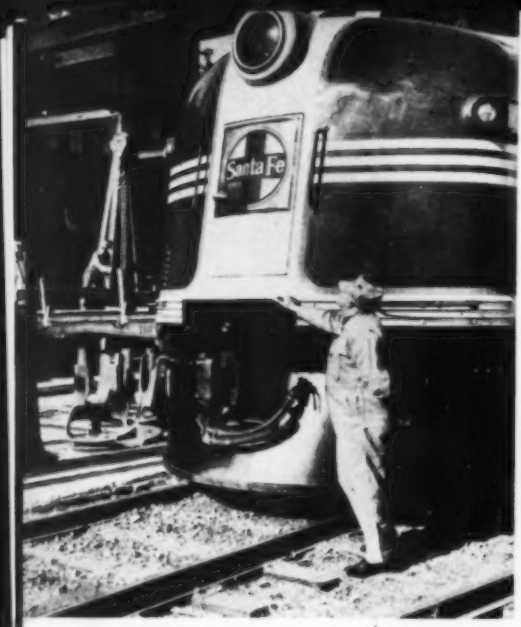
Anything but a stunt, the trip marked the inauguration of a new freight service over the Santa Fe Railroad between Chicago and Los Angeles. Across nine states of widely varying climate, and climbing twice to more than 7,000 feet through the winding passes of the Rockies, the train sped without a slip.

The sleek, four-section locomotive that hauled the heavy train all but the first 200 miles of the route compares favorably with the mightiest of the steam giants. Rated at 5,400 horsepower, it bows to few other engines in that department. Testimony of its ability to haul a given load over a long-distance route in a given time is its recent maiden trip, on which the writer comprised but a minute fraction of the total tonnage, from just beyond the Illinois border at Shopton, Iowa, to the city of Los Angeles —some 2,000 miles in 62 hours running time!

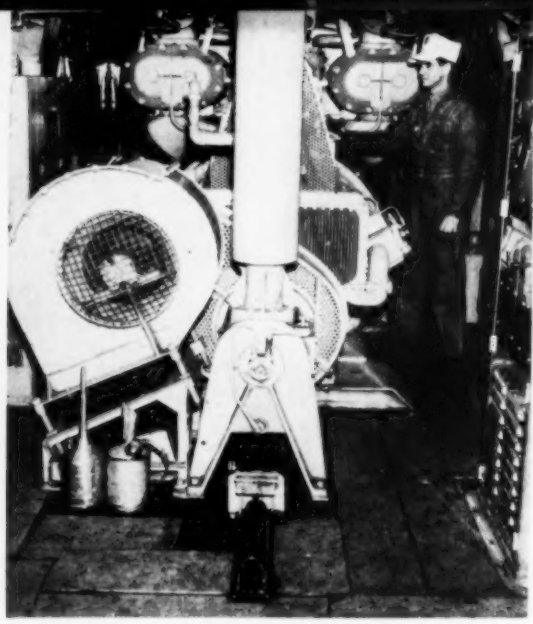
Santa Fe officials hesitate to compare this with steam schedules. But their fastest steam-powered freight scheduled over the full Chicago-Los Angeles run requires nine locomotives. After the first has covered a division or section of some 200 miles, with occasional stops for fuel and water, a second replaces it. Then another takes that engine's place, and so on.

The Diesel freighter covered the entire run alone. It stopped only three times for fuel, and the only water it required replaced the small quantity that evaporated and leaked from its engine radiators and pumps —a problem best compared with that of an automobile on a run of similar length.

Temporarily, the Santa Fe is hauling the freight train across Illinois by steam power, but the new Diesel will take over this sec-

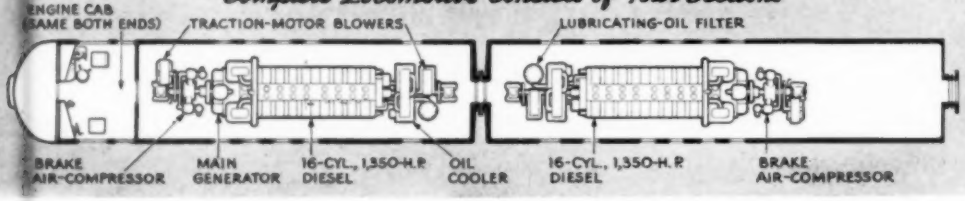


At the Santa Fe shops in Topeka, Kans., an old-time engineer looks over his new charge



Inside one of the four engine rooms, a Diesel "maintainer" works on a 16-cylinder engine as the train speeds on

Complete Locomotive Consists of Four Sections

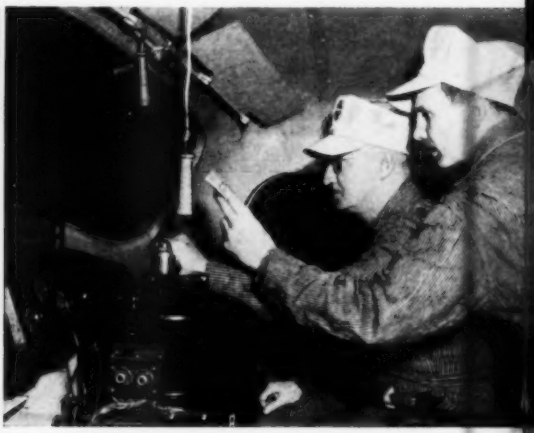


This simplified sketch shows two of the engine sections. Two others identical in plan coupled to them make up the complete locomotive. Control cabs at both ends eliminate the need of turning it around

Leaning from the engine cab yielded this photo of the forward cars of the 64-car train crossing Arizona

The new meets the old. Photo was made from the fireman's seat as the Diesel was hitting well over 60. Note the windshield wiper at upper right, and the brakeman standing atop the oncoming steam freighter

Close-up view of the controls as the engineer sees them. Dial at top tells when power may be increased



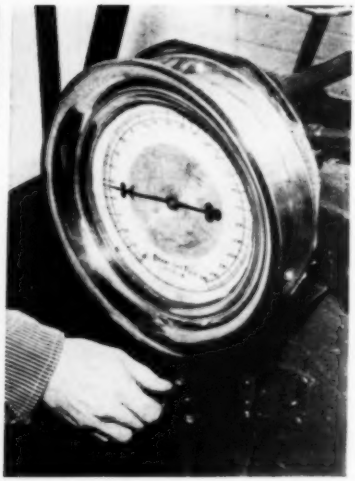
A Diesel maintainer (right) reports on oil consumption to the engineer, who never leaves his controls

tion too as soon as special train-signal controls are installed. Shortly, the locomotive, and another just like it nearly completed at the La Grange, Ill., plant of the Electro-Motive Corporation, General Motors subsidiary, will both be used in the regular service between the two terminal cities. The entire run, now requiring 112 hours under the fastest steam freight schedule, will embrace a weekly trip each way in something less than 90 hours.

Four 1,350 horsepower, 16-cylinder Diesel motors power the 193-foot locomotive, one in each of its four linked sections. Each engine drives an electric generator which in turn powers two traction motors in each of two trucks of each section.

That, simply, is the power plant, but if you care for figures, there's a lot more to be said. For example, the engines are of the two-cycle type, which means that each cylinder fires once for each crankshaft revolution. Therefore, the total of 64 cylinders deliver 51,200 power impulses in each minute of full-throttle operation at the maximum governed engine speed of 800 revolutions a minute—virtually steam-turbine smoothness.

This smooth flow is further ironed out through the electrical system that delivers the power to the 32 driving wheels, all of which carry close to an equal share of the locomotive's average loaded weight of 415 tons. And herein lies one of its most striking virtues. For its smooth power—in excess of 200,000 pounds of pull at the drawbar—always is fully available, whether the giant is pulling away from a dead stop or



In a "dynamometer car" just behind the Diesel, a constant performance record was automatically kept by the moving chart on desk shown at top left. Large dial told drawbar pull, or buff (backing), man in cupola called miles

highballing along at its maximum governed speed of 75 miles an hour!

On steam locomotives the drivers furnish a highly irregular tractive effort—the main cause of wheel skidding—and when stopped at a weak point they often must back and fill to get a train rolling. The Diesel has no such problems.

Down the steep grades of the Rockies, the engine's ingenious new "dynamic brake" got its first severe work-out. In operation of the brake, the traction motors are "reversed" and made to generate current. On electrified railways, such current is fed back into the power lines. On the Diesel, it is fed into grids in the engine roof, not unlike the heating elements in your toaster. Across these grids, huge fans blow cooling air. Thus, unwanted heat ordinarily generated at the wheels by application of the air brakes is harmlessly dissipated, and time-wasting stops to allow car wheels to cool off are eliminated. In use for 83 miles on the trip, the system reduced air-brake application by 75 percent.

Tracks take less pounding under Diesel locomotives with their low center of gravity, smooth operation, and well-distributed load, and Diesels are "available," or fit for service, 95 percent of the time, compared with only 33-percent availability for steam locomotives. They require only a fraction of the number of fuel and water stations along the right of way.

It was only six years ago that the Santa Fe acquired its first Diesel switching engine. Today, it has 43 switchers and 23 high-speed passenger locomotives, in addition to the freighter and its twin shortly to be delivered. There are no other engine types, so the Santa Fe becomes the first railroad in the world to use Diesels in all branches of its service.

In the jargon of railroad men, the Santa Fe has given the "clear board"—green signal—to the Diesel!

How Homes Can Be Protected from Air Attack

By A. M. PRENTISS

Lieutenant Colonel, General Staff Corps, U. S. Army

BY BREAKING DOWN the hours of work and leisure of the average citizen it has been estimated that the chances are better than three out of five that an enemy bombing attack will take place while he is at home. Thus, protection of the home and those within it becomes of paramount importance.

There are five general types of shelter a home owner may use, and his choice will depend on such considerations as expense, ease of construction, comfort, and vulnerability. These types, shown on the following pages, are:

1. A refuge room, within his home.

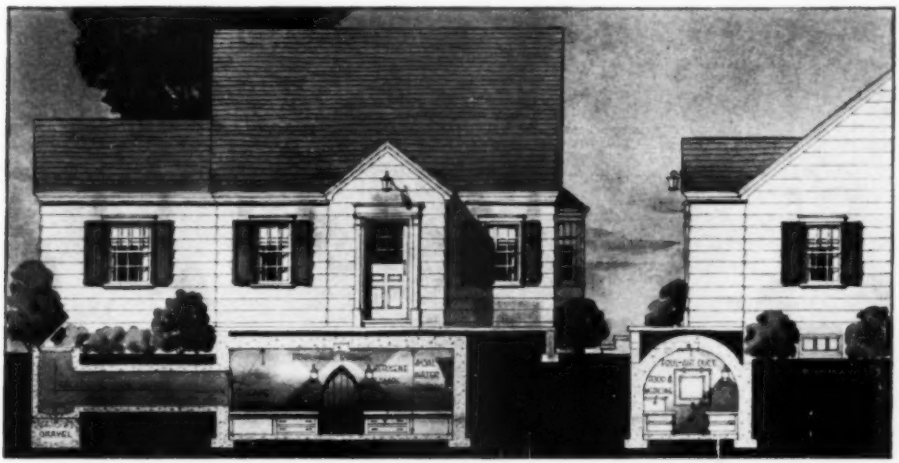
2. An open trench in his yard. This is good protection against blast and splinters from a high-explosive bomb, but is no protection against gas or falling splinters from an antiaircraft shell, and is a miserable makeshift in inclement weather.

3. A trench dug at least 6 feet 6 inches in the ground, with side walls of planks or corrugated iron and covered with 2 to 2½ feet of earth supported by planking or corrugated iron. For the sake of safety from a direct hit on the home, such a trench *should be built at least half the distance of the height of the walls away from the house.* This trench is safer than a room in the house, but is apt to be uncomfortable.

4. A semisurface type of trench, like the Anderson type in use in England, formed by placing preformed arched sections of sheet steel or reënforced concrete in a trench 3 or 4 feet deep and covering the sections with earth to a depth of 2 to 2½ feet. These give as much protection as the covered trench, but are more expensive and suffer the same disadvantages of discomfort.

5. Shelters that are essentially pill boxes, built on the surface of the ground of concrete or brick. The external walls should be 13½ inches standard brickwork, or 15 inches of sound concrete; the interior walls should be 4 inches of brickwork and the roof should be built of 5 inches of reënforced concrete. They should be placed within 6

(Civilian preparedness and morale are essential attributes of victory in modern warfare. The following article, telling how civilians may best defend themselves and their homes against air attack, is an authorized condensation from chapters in a soon-to-be-published book, "Civilian Air Defense," by Lieutenant Colonel Prentiss.)



Ready-made air-raid shelters are provided for 21 medium-priced houses being constructed by Pontiers Built Homes, Inc., at Ocean City, N. J. Builders explain that in peace they make good game rooms

to 15 feet from the house in order that the walls of the house may serve as additional blast protection. These shelters are comfortable, dry, but expensive.

The required standard of overhead protection against blast and fragments from a 500-pound bomb bursting 50 feet away is afforded by: $\frac{1}{4}$ inch of mild steel plate; 4 inches of reënforced concrete; 6 inches of ordinary concrete; brickwork or masonry arches of not less than $8\frac{1}{2}$ inches crown thickness; or 18 to 24 inches of earth, sandbags, ballast, or broken stone. If immunity against direct hits of the most frequently used bombs (i.e., up to 550-pounds) is desired, the overhead cover of the shelter must be increased to a minimum of 7 feet of reënforced concrete.

Since protection on this scale for large numbers of people would involve immense cost, it is considered impracticable for general use, and the first-mentioned standard of overhead cover is the one most widely used. The required standard of lateral protection for outdoor shelters is secured by $1\frac{1}{2}$ inches of mild steel plates; $13\frac{1}{2}$-inch walls of good brickwork (i.e., $1\frac{1}{2}$ bricks thick), or sound stone masonry; 12 inches of reënforced concrete; or by 30 inches of earth, sandbags, ballast, or broken stone.

All these types of shelters, it should be stated parenthetically, are not designed to offer protection against a direct hit of a high-explosive bomb, such as the general-purpose bomb, the kind generally used against urban areas. The heavier 660-pound to 4,000-pound demolition bombs usually are reserved for specific military targets, and the smaller 22-pound to 55-pound fragmentation bombs are designed for attack on troops in the field.

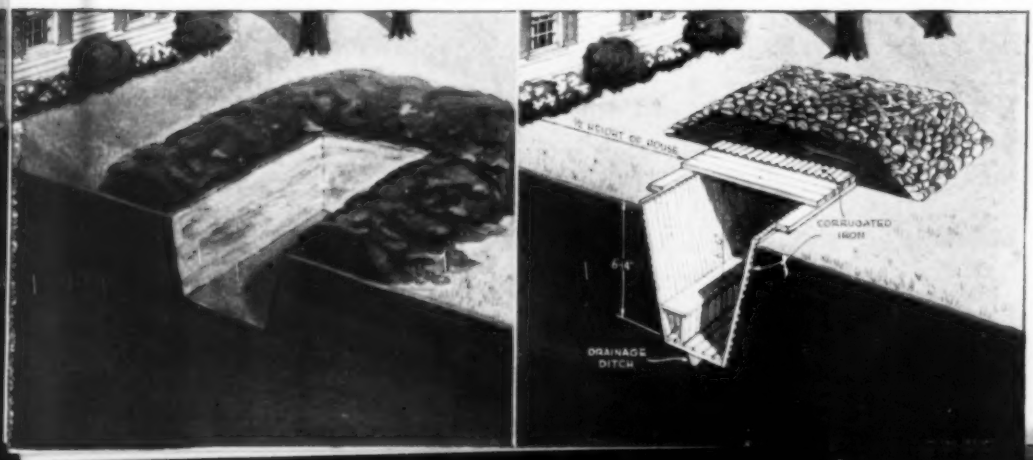
Civilians have most to fear from general-purpose, high-explosive bombs, which range from 45 to 550 pounds; gas bombs, from 22 to 550 pounds, and gas sprays; and from incendiary bombs, ranging from 2 1/5 pounds to 55 pounds. The small type, known as the electron bomb, and consisting of a magnesium tube filled with powdered aluminum and iron oxide, called thermite, is considered the most effective. One large bomber can carry from 1,000 to 2,000 of these small incendiaries and scatter them over a wide area.

To the average house owner the refuge room, for reasons of economy and comfort, has usually a greater appeal than any other type of domestic shelter. But if his house is of light wooden construction a refuge room will not afford the necessary amount of safety for himself and his family and he must choose one of the other types of shelter. For it requires $13\frac{1}{2}$ inches of brickwork to give full protection against bomb splinters and 9 inches of brick wall to stop the majority of splinters.

Fortunately this does not mean that a refuge room must be inclosed in 9 to $13\frac{1}{2}$ inches of brick in order to be comparatively safe. The thickness of all walls within 30 feet from the refuge room may be considered as added to the thickness of the room walls. The house next door, for example, if it is within the 30-foot limit, or a high garden wall, could be considered as part of the protection of a refuge room.

As a general rule, a refuge room in the basement is preferable, since it affords the best protection against blast and fragments. In stories above the ground level there is always danger that fragments from high-explosive bombs falling near a building will strike upward through a window below the room and then through the floor of the room. For this reason, when a refuge room in the basement is not feasible, a protected room on the ground floor is usually the best location for a refuge room. The next-best location is an inner room upstairs, but not on the top floor. The guiding principle is to choose a room that already is protected as much as possible by surrounding walls

Four types of outdoor shelters that home owners can build for themselves: at left, below, an open trench in the yard; at right, a similar trench with walls of planks or corrugated iron and a covering of earth



of brick, stone, or concrete, including those of the house next door.

The most favorable place for a ground-floor or upstairs refuge room is a corridor or an inner room without windows, or a room with a window facing a narrow court or alley, so as to secure partial protection from neighboring walls. Windows and doors of refuge rooms which are not already shielded by another house or solid wall within a distance of 30 feet must be especially protected against bomb blast and splinters by blocking them up, or by erecting barricades around them outside the building. In either case the protection should be raised to a height of at least 6 feet above the floor of the room so that occupants will be out of danger of splinters.

The simplest way to block a window or door that is not needed is to brick it up with good brick masonry, $1\frac{1}{2}$ bricks (13") thick. A less expensive method is to build a frame crate over the outside of the window and fill it with earth, loose gravel, or shingle, to a thickness of 24 to 30 inches. The most effective method of protecting a window against the blast of high-explosive bombs is to construct around the outside of the window sandbag walls or earth traverses 2 feet 6 inches thick, which must entirely cover the window opening and abut the brickwork with an overlap of at least one foot all around.

The protection of windows is extremely important, for gas may be used by the enemy concurrently with high-explosive bombs, and the shattering of the windows would permit gas to seep into the room. Where windows cannot be protected by barricades it is necessary to reënforce or replace the ordinary glass by some non-shattering transparent or translucent material such as celluloid, or cellulose acetate applied with cellulose varnish to the inner surface of the pane; or vitreo celloid material, such as "cellatoid" reënforced by $\frac{1}{2}$-inch wire-mesh netting, substituted for pane; or glass internally reënforced by wire-mesh netting; or finally by oil-impregnated, gasproof blankets nailed over windows on the inside.

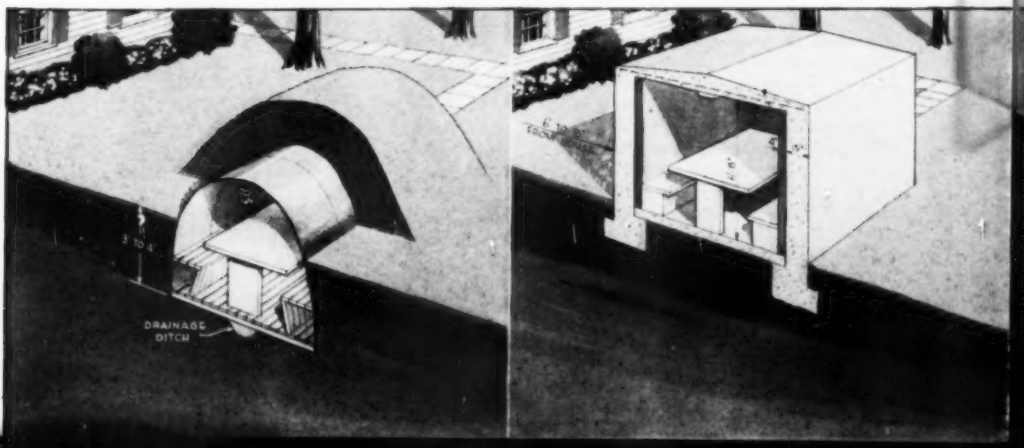
A covering over the pane, such as tough paper, cardboard, cloth, or cellophane, can not prevent a pane from breaking when a bomb explodes near by, but it can prevent glass from flying about in dangerous fragments.

As a general rule, a small or narrow room is preferred for refuge purposes, provided it has sufficient area and cubic space to meet ventilation requirements, for the reason that its roof or ceiling will be more resistant to a load of falling debris than a room of underspan. Where material and labor are available for propping up the ceiling over the refuge room, it is not so important to choose a small and narrow room. Rooms with large windows, and especially bay windows, should, of course, be avoided.

An added precaution to exclude gas from filtering into refuge rooms through broken windows is to attach to the inside of the window a flexible shutter, hinged at the top so that it will momentarily yield to the blast impulse but return to an air-tight position almost immediately. Such a shutter may be made of wall boarding, plywood, or other resistant material fixed to a light wooden frame, accurately fitted to the window opening and having a rubber, felt, or thick cloth strip tacked around its contacting edges. The shutter should be held in place only by its friction with the window frame, so as not to offer resistance to the blast impulse, but to swing freely and then return to its position against the frame.

Since no serious amount of gas will enter a room unless there are air drafts to carry it in, all extraneous openings should be stopped up. This can be accomplished by filling all cracks and crevices in the walls and ceiling with putty, or pulp made of wet

A semisurface shelter, like the Anderson type used in England, is seen at the left. It uses preformed sections of steel or concrete. At right, a pill box built on the ground surface, of concrete or brick



1 Tables and chairs.

2 Water for drinking, washing, and fire fighting.

3 Books, cards, writing materials, toys.

4 Large fire buckets.

5 Stirrup hand pump for water.

6 Sand and shovel for extinguishing incendiary bombs.

7 Paper and paste or gummed paper for covering window panes and sealing cracks.

8 First-aid kit.

9 China and cutlery.

10 Canned food and can opener.

11 Food chest with gas-tight containers.

12 Sanitary facilities and disinfectant.

13 Spare blankets or rugs for resealing windows.

14 Pickax and shovel for clearing debris.

15 Electric grill for cooking and heating.

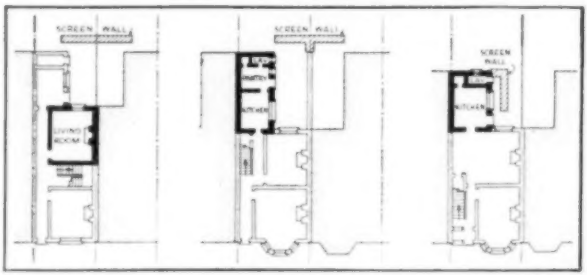
16 Flash lights and matches.

17 Mattresses, blankets, and other coverings.

18 Radio receiver.

19 Raincoats, rubbers, and gum boots.

Where conditions permit, a refuge room inside the house affords the maximum of comfort and economy. Listed at the left are the articles that Lieutenant Colonel Prentiss considers essential for equipment



How refuge rooms might be located in three different houses. In each case, a special screen wall has been constructed in such a way as to give the greatest possible protection from blasts in the open court

newspaper, or by pasting them over with strong gummed paper. All trap doors, skylights, and ventilators should be sealed, and if there is a fireplace the flue should be stuffed with rags, paper, or sacks; or better still, the opening should be closed with a sheet of plywood and adhesive tape.

Care should be taken to seal up all cracks between and around window sashes, and gas curtains should be fitted to all doors. A gas curtain is constructed by fastening a blanket with strips of wood on the outside of the door frame, except for some 5 feet above the floor on the side away from the hinges. The bottom of the blanket is left loose at that corner, so that it can be lifted up to let a person through. About one foot of the blanket is left trailing on the floor to prevent air drafts under it. If the blanket is impregnated with oil, it gives better protection.

If a refuge room is situated below the top floor of the house, as it should be, there is little danger of a direct hit by an incendiary bomb entering the room, for such a bomb does not penetrate a house below the attic floor. The bomb must, however, be extinguished promptly, for the thermite burns fiercely at 3,000 degrees centigrade for about one minute, *(Continued on page 218)*

Are Skyscrapers Bombproof?

AMERICAN TYPE OF BUILDING MAY BE ANSWER TO RAIDERS

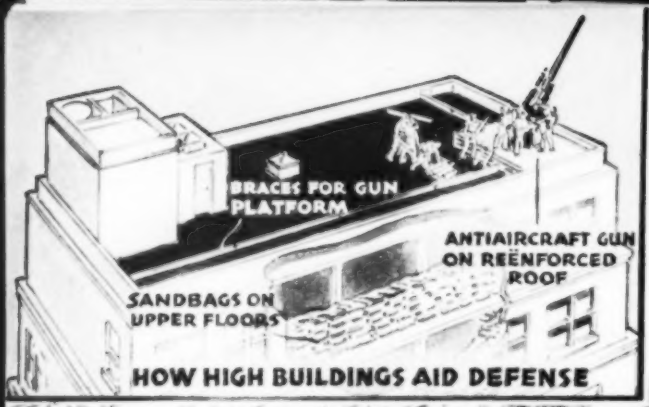
AMERICAN skyscrapers, often the butt of foreigners' jokes, stand ready to attain a new and indispensable usefulness. In the view of experts, they constitute a highly satisfactory, if not impregnable, defense against all types of bomb attacks. Even without added safeguards, they can safely protect millions of city dwellers and workers from explosives, gas, and incendiaries. And by the addition of sandbags and steel in vital sectors, they can be made almost as safe as the most elaborate shelter.

Those same Europeans who have laughed at our huge towers of steel and reënforced concrete regard them enviously today, for they have seen their own buildings of wood, brick, and masonry crumble to dust and rubble, graveyards for their hapless occupants. Their few modern structures, however, have withstood the heaviest assaults of incendiary and demolition bombs. Residents of New York with its Empire State, Chrysler, Bank of Manhattan, and forty other towers more than 400 feet high; Chicago, where the Board of Trade, Temple, and almost a dozen others top 500 feet; Detroit, with the Penobscot, and Pittsburgh, with the Gulf Building, enjoy ample protection. Every American city has buildings that afford a large degree of safety.

In the opinion of Ely Jacques Kahn, eminent architect of New York City, skyscrapers are "naturals" as a

What bombs do to European-type buildings of wood, brick, and stone: a scene in a residential area of London after it had been hammered by raiders

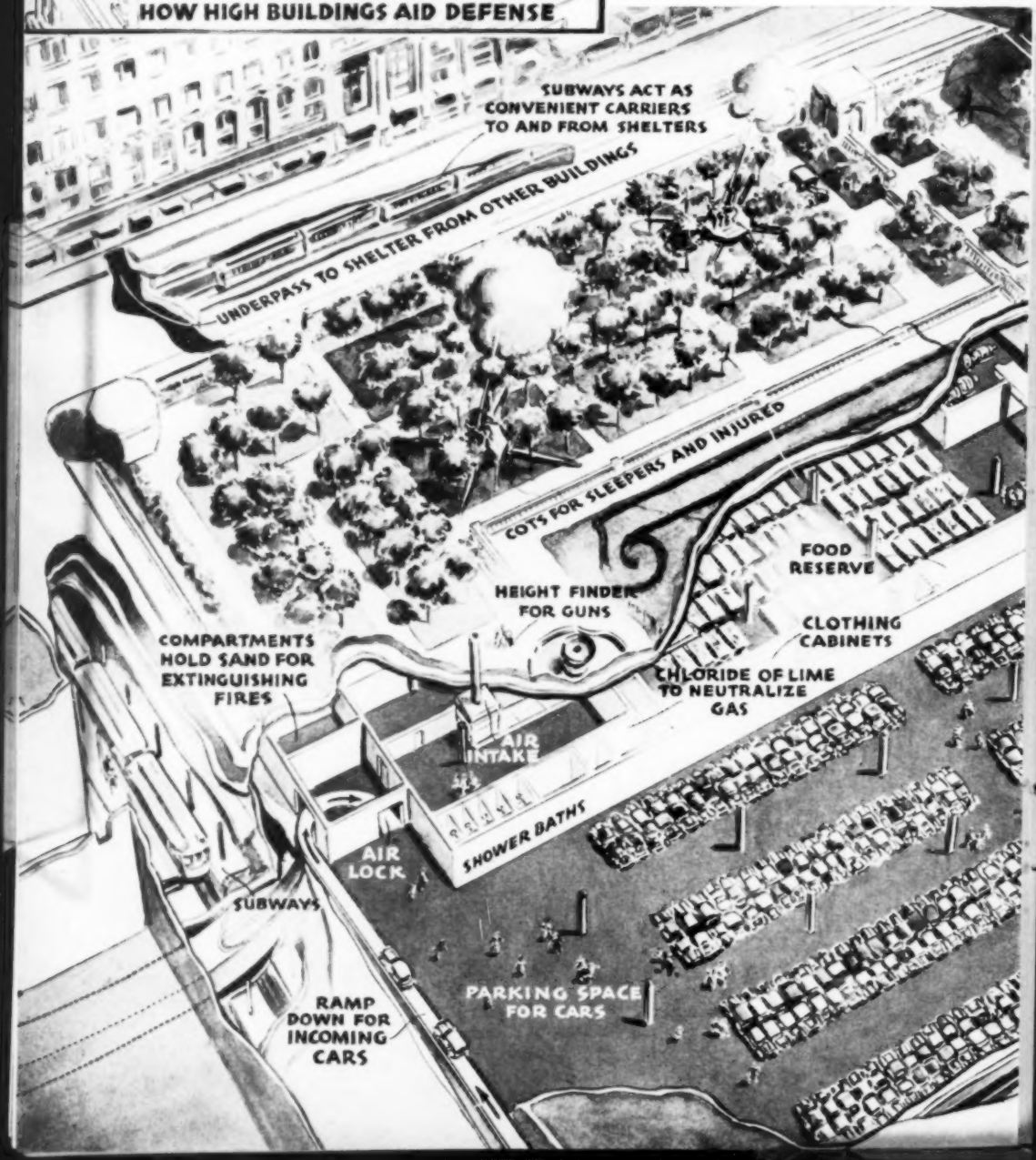
And this was a business building. American skyscrapers of steel and concrete are believed to offer better protection



HOW HIGH BUILDINGS AID DEFENSE

bomb defense. The common demolition bomb of 550 pounds will penetrate a maximum of eight stories through a steel roof and steel and reënforced concrete floors. With the added protection of sandbags the penetration may be limited to three floors. The

Ely Jacques Kahn's plan for


SUBWAYS ACT AS CONVENIENT CARRIERS TO AND FROM SHELTERS
UNDERPASS TO SHELTER FROM OTHER BUILDINGS
COTS FOR SLEEPERS AND INJURED
FOOD RESERVE
HEIGHT FINDER FOR GUNS
CLOTHING CABINETS
COMPARTMENTS HOLD SAND FOR EXTINGUISHING FIRES
CHLORIDE OF LIME TO NEUTRALIZE GAS
AIR INTAKE
SHOWER BATHS
AIR LOCK
SUBWAYS
PARKING SPACE FOR CARS
RAMP DOWN FOR INCOMING CARS

most powerful explosive, upon hitting the street, will not hurl fragments able to penetrate modern walls higher than three stories. Poison gas cannot rise more than two or three floors above street level. Incendiaries, weighing only a few pounds, may not penetrate

a shelter under a city park

even through a modern building's roof. Even if they do, they must burn through almost completely fireproof floors and walls.

Refugees in a skyscraper, then, provided they remain three floors above the street and five or six floors below the roof, are safe from anything except a direct hit which may be directed at them slantwise. For bombs never fall straight; they strike whatever is in their path at an angle. Experience abroad, however, has shown that even a hit like this is a minor catastrophe. It will undoubtedly kill or wound persons sheltered at that level. Striking at the 25th floor, for example, it may penetrate diagonally down to the 20th, killing and maiming en route. But the building's steel frame is flexible; it will take the shock without collapsing.

No surface structure, modern or otherwise, can be made impervious to a direct hit except at terrific cost, and it is likely that skyscrapers will have to continue to take that risk. Important safeguards such as sandbagging on the top floors, placing sandbags between floors and windows to protect against flying fragments, and bracing windows or covering them with metal sheets, will add greatly to the general safety.

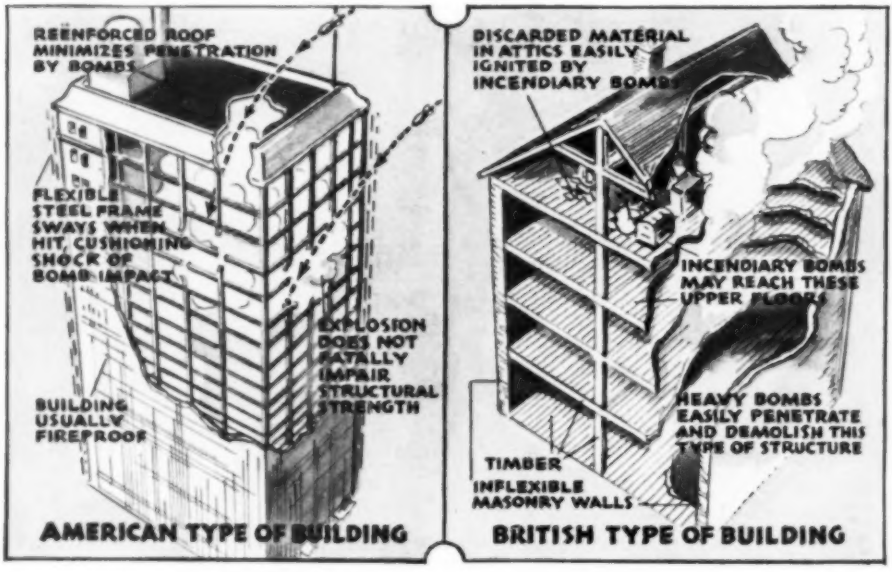
The skyscraper's defense rôle however is not limited to protection alone. Military experts concede that the heavily reënforced roofs would easily support antiaircraft-gun emplacements, and shelters for gun crews.

Unique and permanent underground shelters may be the solution in our cities' most crowded areas. In emergencies they may be used as shelters for almost indefinite periods, completely equipped with food-storage, sanitary, and dormitory facilities; power units for lighting, heating, and ventilating; and ample ingress and egress motorways. A seven-foot layer of reënforced concrete, and reënforced concrete walls, would give them protection against demolition bombs.

In time of peace these subterranean palaces, acres in area, may be transformed into useful civic projects. Thousands of automobiles may find storage and parking space there, new municipal markets, theaters, skating rinks, swimming pools, gymnasiums, auditoriums, and schools may be located there, far from dirt, noise, and traffic.

Ely Jacques Kahn together with his partner, Robert Allan Jacobs, has even envisaged these combination war-and-peace villages as the modern answer to the problem of slum clearance. Mr. Kahn is famous for the designing of many of New York's best-known buildings and department stores, such as the Squibb Building, 120 Wall Street, Bonwit Teller, Bergdorf-Goodman, and Jay Thorpe. Slums, he says, are peacetime hazards; they are worse in wartime. Raze them, therefore, and in their stead erect vast areas of parks, playgrounds, and apartment houses, with permanent shelters beneath them.

Bombs striking a building of structural steel and concrete do only local damage; less flexible structures are demolished


REENFORCED ROOF MINIMIZES PENETRATION BY BOMBS
FLEXIBLE STEEL FRAME SWAYS WHEN HIT, CUSHIONING SHOCK OF BOMB IMPACT
EXPLOSION DOES NOT FATALLY IMPAIR STRUCTURAL STRENGTH
BUILDING USUALLY FIREPROOF
AMERICAN TYPE OF BUILDING
DISCARDED MATERIAL IN ATTICS EASILY IGNITED BY INCENDIARY BOMBS
INCENDIARY BOMBS MAY REACH THESE UPPER FLOORS
HEAVY BOMBS EASILY PENETRATE AND DEMOLISH THIS TYPE OF STRUCTURE
TIMBER
INFLEXIBLE MASONRY WALLS
BRITISH TYPE OF BUILDING

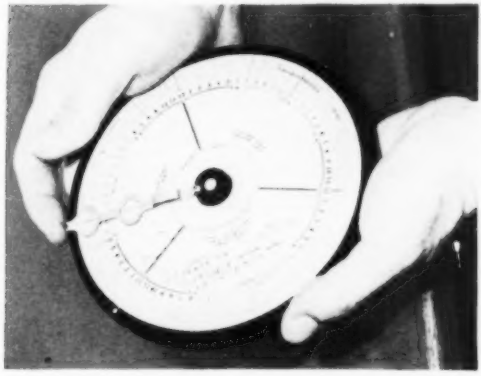
Fly Yourself in a Rented Plane

NOW you can fly yourself in a rented plane, and pay only for the time you fly even though you keep the ship for a week or a month. Automatic clocks which keep an accurate record of the number of hours the ship is in the air are being installed in many rental planes to avoid arguments between pilot and owner as to just how long the ship was in use. This also provides a record of flying time for student pilots building up "hours" for radio, instrument, or cross-country license requirements.

When you climb into one of these new fly-it-yourself planes, you know you'll pay only for time in the air

The renting company puts an automatic timer in the ship. It operates only when the plane is in flight

When you return the plane—after a day, a week, or a month—the "meter" shows exactly how much you owe



MAGIC-LANTERN CARTOONS TRAIN ARMY MECHANICS

MAGIC LANTERNS have joined the Army. Projectors that are direct descendants of the parlor lanterns of a generation ago are now being used to train rookies in the mechanics of modern motor vehicles.

They are used with what are known as "educational reading slidefilms," because this has been found to be the speediest and most effective means of training mechanics. And speed is necessary, because by this coming June the Army expects to have 190,000 motor vehicles.

The "textbooks" are 35-mm. films on which are recorded the intricate details of the anatomy of automobiles. The films are projected one frame at a time, and are moved through the projector manually by a knob on the side of the machine. Step by step they present all the theoretical information that an Army mechanic needs, start-

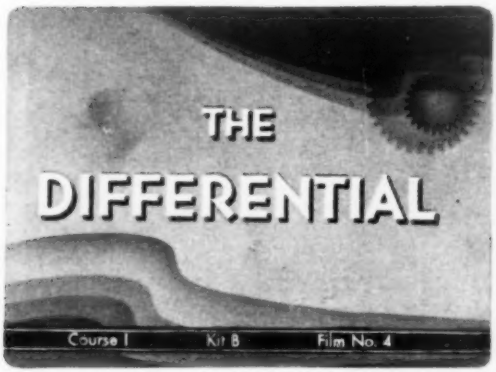
The Army's new teacher of automobile mechanics: projector and kit of 35 "slidefilms." Below, learning about carburetors

ing with the reason for the existence of various parts, and ending with complete instructions on how they should operate and how to keep them operating that way. If the lighting conditions in the classroom are carefully controlled, there is sufficient illumination for the students to make notes and even copy the sketches and diagrams as they are projected on the screen.

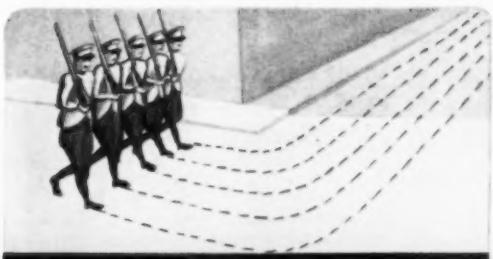
The "Army kit," which was made by the Jam Handy Organization, producer of industrial motion pictures, comprises 35 separate films, and to make them more than 3,000 drawings and a year's work were required. This course, for specialized training, is divided into five smaller kits, covering internal-combustion engines, power transmission, factors of mobility, electrical systems, and general service and repair of automobiles.

Forty duplicate kits are now in use. They are in part responsible for the Army's ability to turn out a trained mechanic in three months or less.

Here are six frames from the slidefilm explaining the differential. Pictures and text are combined to show the rookies why a car needs a differential in the first place, and how it is made



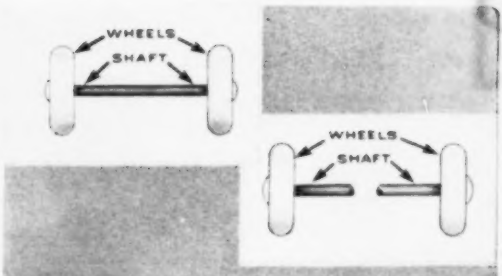
In this film we will investigate the construction and operation of the DIFFERENTIAL. First, however, let's look at a few simple principles that will show us WHY a differential mechanism is necessary in the automobile.



When a line of men marches around a corner, the man farthest away from the center of the turn has the greatest distance to travel. The inner man has the shortest distance to go.

In the early automobiles, the principle of allowing the rear wheels to rotate separately on the rear axle was used. Only ONE of the wheels was connected to the ENGINE in this case.

In the automobile, BOTH rear wheels must be driven by the engine, but they must also be able to turn at different speeds when necessary. The device that makes this possible is called the DIFFERENTIAL, because it can drive the rear wheels at DIFFERENT speeds.



Let's start by cutting the single axle in two at the center. Now each wheel is mounted on a separate axle shaft.

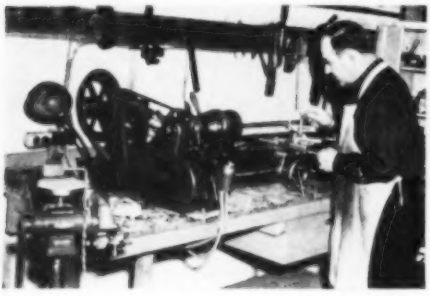
The comfortable shades protect the wearer from eye injury caused by sunlight during a prolonged sun bath

Lightweight Metal Sunshades Protect Eyes of Sun Bathers

FORM-FITTING sunshades now protect the eyes of a vacationist seeking a coat of tan. Joined by a light wire, a pair of spoon-shape covers enable a wearer to open or close the eyes beneath them. Made of aluminum, the shields are comfortably light in weight, and an outer finish of aluminum paint is said to reflect sunlight and prevent overheating.

Air-Line Pilot Gets Back to Earth Making Guns in Spare Time

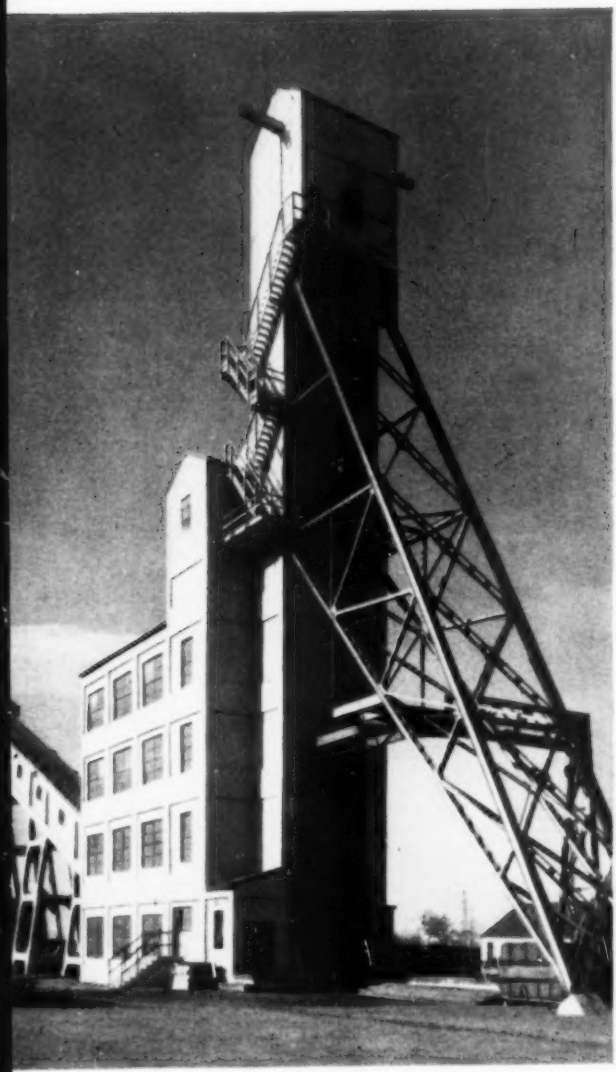
MAKING fine guns in his basement workshop provides a spare-time hobby for Capt. Joseph A. Hammer, American Airlines pilot. With a specially built lathe and tools he made for himself, he has turned out 25 precision weapons of original design. On one of them, a combination rifle and shotgun, the rifle barrel may be removed to leave a double-barrel 20-gauge shotgun.



Capt. Joseph A. Hammer with some of the 25 precision guns he has made in his basement home workshop, where he is pictured, left, drilling a rifle barrel

1,000-Acre Saltcellar

AMERICA'S LARGEST SALT MINE, WHERE WORKERS IN WHITE ENJOY NATURE'S AIR-CONDITIONING



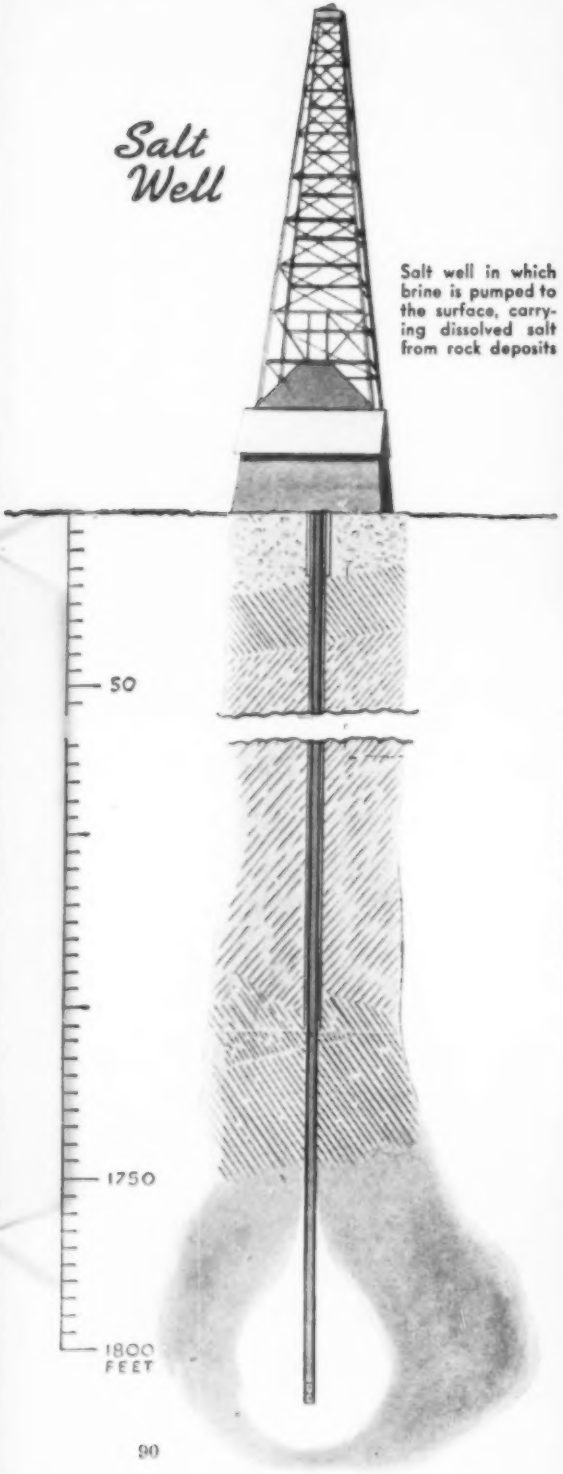
MINERS in white overalls working "diggings" where nature provides the air-conditioning, may seem a coal miner's dream. But they are commonplace features of the largest salt mine in the Western Hemisphere, buried 1,000 feet beneath the ground at Retsof, N. Y.

Even the foreman's office, drafting rooms, and machine shops are down in the mine. They are set up in caverns carved from rocks of salt, to take advantage of the ideal working conditions. The surrounding earth maintains an unvarying temperature of 63 degrees, and the salt absorbs excess moisture. The only man-made accessories to the air-conditioning system are the ventilation fans.

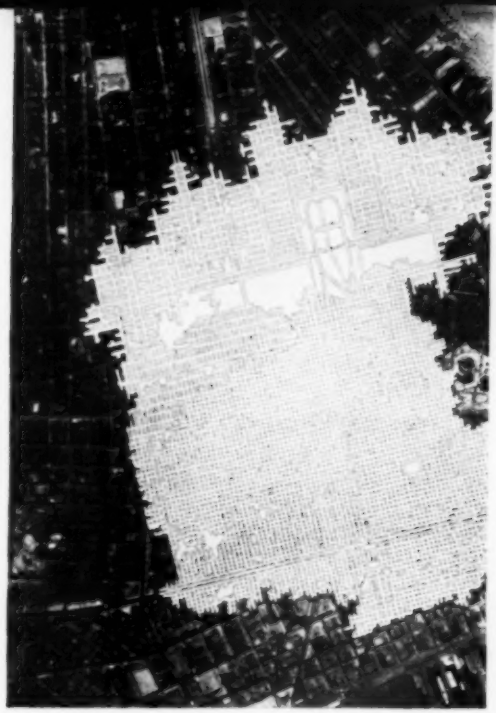
One of three such mines operated by the International Salt Company (others are at Detroit, Mich., and Avery Island, La.), the Retsof workings spread over more than 1,000 subterranean acres, almost the size of the lower end of New York's Manhattan Island. Some of its white-walled corridors are two miles long, and a man can walk the entire 15 miles of the mine's circumference without ducking his head.

In mining the salt, huge saws cut vertical and horizontal slots in the sides of the veins, which are sometimes 100 feet thick. This gives the dynamite a chance to break up the greatest amount of rock with the least amount of danger to mine and miners. After the blast, squat electric locomotives hustle empty cars to the salt pile. When they are loaded, the salt is hauled to a dump near the main shaft, where the cars are lifted and turned upside down to unload their cargoes into a giant crusher. This reduces the rock

Salt Well



Salt well in which brine is pumped to the surface, carrying dissolved salt from rock deposits



Just to give you an idea of how big the Retsof 1,000-acre salt mine is, it has been put . . .

slabs to eight-inch lumps, and then "skips," or buckets, hoist the salt to the breaker house at the head of the shaft.

Although rock salt is mined, the salt which reaches your table comes principally from wells. They are of two types. In one, natural brine is pumped from the well, and in the other water is forced down into a deposit, where it dissolves the salt.

The ancient Chinese followed the principles used today in obtaining salt from brine when they evaporated sea water in the sun. That method is still followed in

Electric locomotive hauls 25-car salt train . . .

(Acro Service Photo)

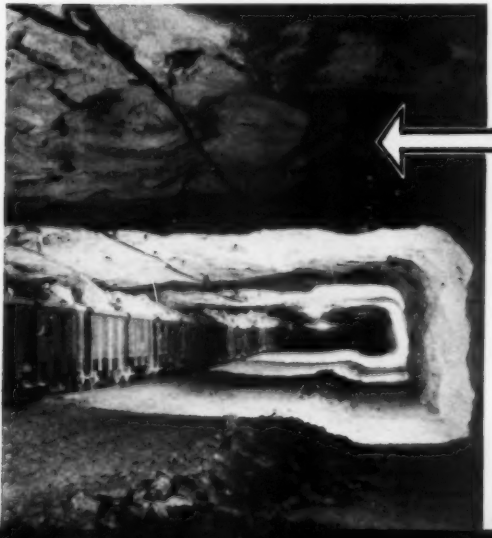
. . . on top of a view of lower Manhattan. Some of its white-walled corridors extend two miles

some countries, but here the evaporation process is generally speeded by huge "vacuum pans," some of which stand 45 feet high and can produce 200,000 pounds of salt a day.

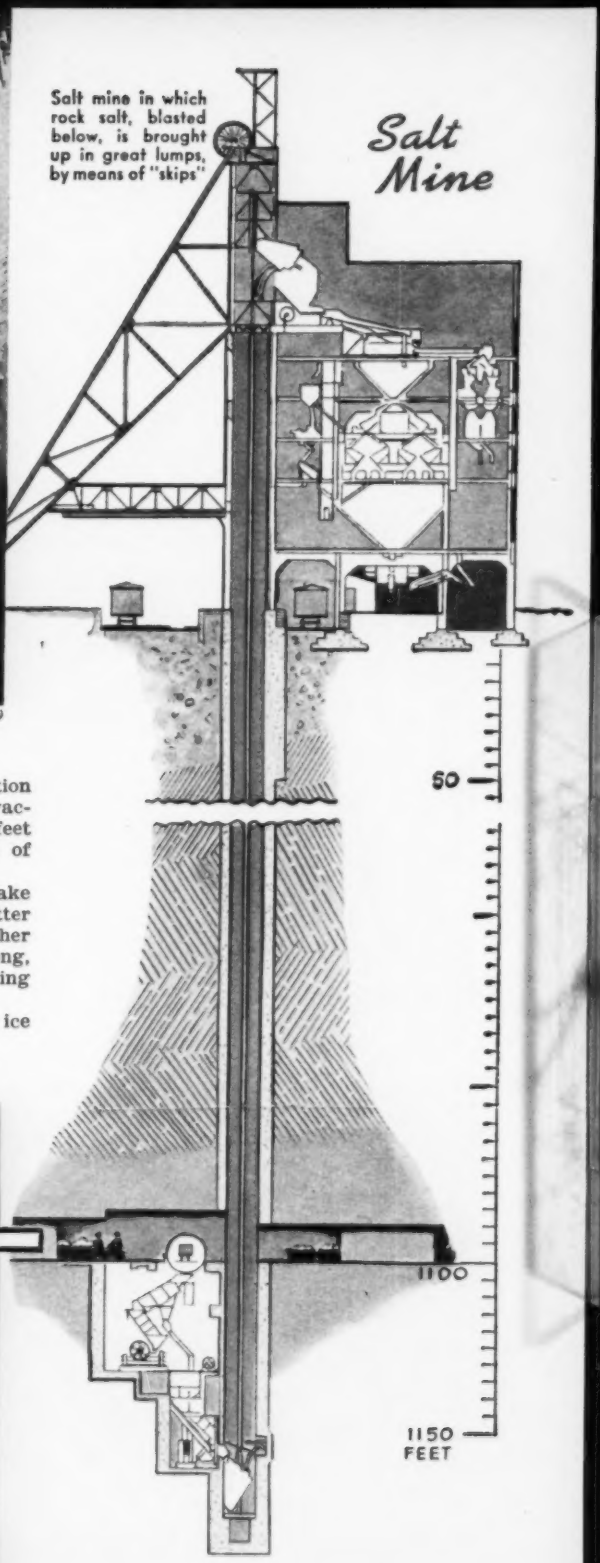
Evaporation is used also in making flake or "grainer" salt, needed in making butter and pretzels, and in curing meats and other foods. Here the evaporation is done in long, shallow vats, with steam pipes running through them.

Rock salt is chiefly used for making ice cream, and for melting ice on streets.

. . . through salt-walled tunnel, 40 feet in width



Salt mine in which rock salt, blasted below, is brought up in great lumps, by means of "skips"



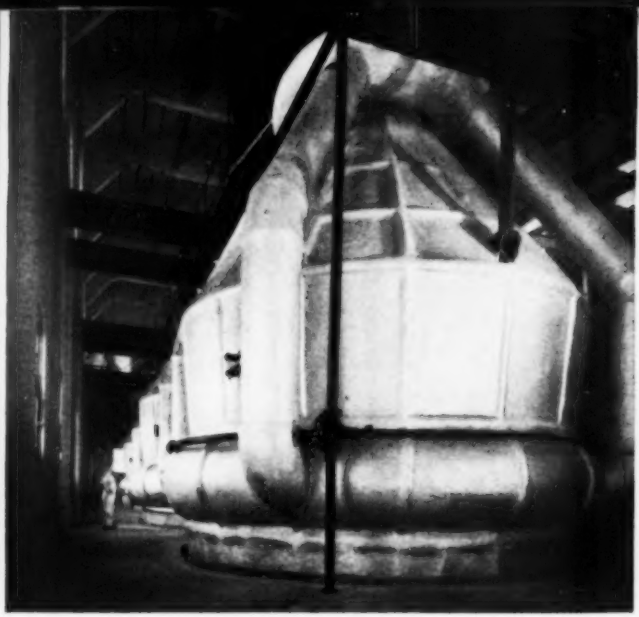
1 Deep underground, a salt miner (left) drills a hole for dynamiting. This is at the Avery Island, La., mine, which has been worked so long that the interiors are big enough to permit blasting

2 The blast throws hundreds of tons of rock salt to the floor of the mine, to be scooped up by steam shovel. It's comfortable work, for the salt walls absorb moisture and the temperature is even

4 Salt, brought to the surface in lumps by overturning "skips," is poured over screens, where inspection and a preliminary grading takes place. Finer screening follows later

3 Subterranean machine shop, 195 by 30 feet, with rock-salt walls 9½ feet high. Modern lighting comes from 500-watt indirect units, and machines stand on concrete beds set in the rock-salt floor

5 Electric "shaker screens" carrying on the grading of the salt. This process assures uniform size and removes all "salt dust." Coarser rock-salt grades are used in industry

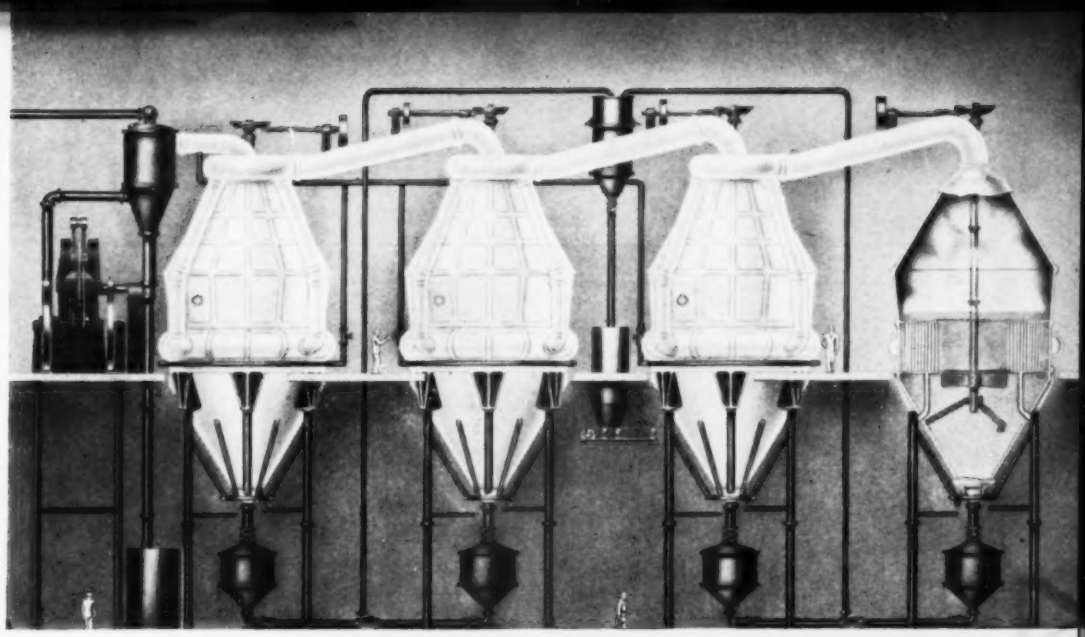


6 After undergoing its first breaking and screening process, the salt is still in hard, tough, eight-inch lumps. On the floor below the primary screens it is further reduced by these crushers

8 Also from rock-salt mines, but by a different method, salt for table use is obtained. It is brought to the surface as brine, and the water is evaporated off in these huge "vacuum pans." Often four of them . . .

7 Final screening and grading is followed by packing. Coarser salt is packed in bags, and much of it is used by home owners and janitors throughout the country to melt sidewalk ice

9 Vacuum-evaporated refined salt for home use is packed by machinery in these familiar containers with adjustable spouts through which the salt can be poured into table shakers. The girl watches the machine feed the salt in by those same spouts



. . . are linked to form a "quadruple effect" unit. Pans are 18 to 22 feet wide and 36 to 45 feet high. Copper tubes in center form steam belt

Did You Eat Your 6-Pound Ration of Salt Last Year?

The average American uses six pounds of salt a year as a condiment. As much more goes into preparing and preserving his food.

Seventy-nine plants in U. S. produce nine million tons of salt annually. It's worth about $24,000,000.

Centuries will pass before known deposits of salt are used up, and there will still be 3 percent, by weight, of salt in the sea.

Here's My Story

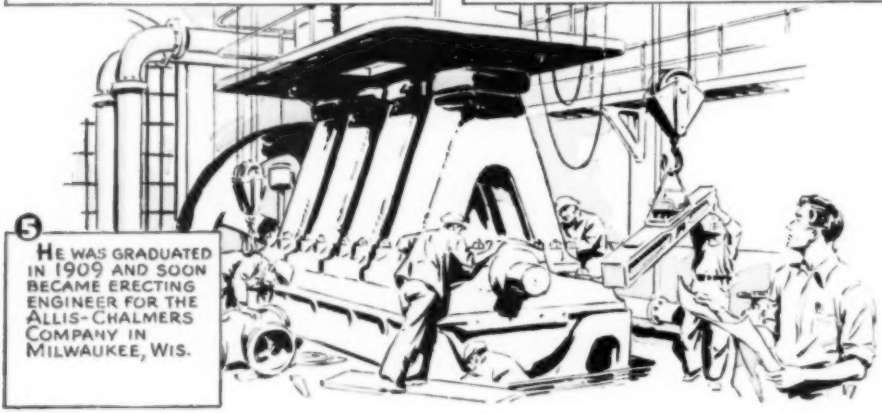
TODAY FRED MORRELL ZEDER IS DIRECTING ENGINEER OF THE CHRYSLER CORPORATION

1 WATCHING TRAINS IN HIS NATIVE BAY CITY, MICH., INTERESTED YOUNG FRED ZEDER IN ENGINEERING

2 HE WENT TO WORK AT 11, FILLING PART-TIME JOBS AS A RAILROAD CALL BOY AND CAR CHECKER

3 AFTER HIGH SCHOOL, HE LANDED A FULL-TIME JOB IN THE MOTIVE POWER DEPARTMENT OF THE MICHIGAN CENTRAL RAILROAD

4 WITH HIS SALARY FROM THAT JOB, PLUS WHAT HE EARNED VACATIONS, HE STUDIED MECHANICAL ENGINEERING AT THE UNIVERSITY OF MICHIGAN

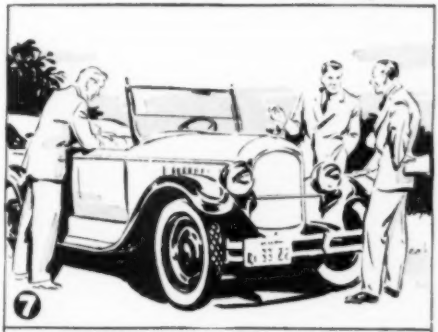


5 HE WAS GRADUATED IN 1909 AND SOON BECAME ERECTING ENGINEER FOR THE ALLIS-CHALMERS COMPANY IN MILWAUKEE, WIS.

THE CAREER OF FRED M. ZEDER

6

NOT SATISFIED WITH THAT, HE JOINED THE STUDEBAKER CORPORATION IN 1913 AS CONSULTING ENGINEER; LATER BECAME CHIEF ENGINEER



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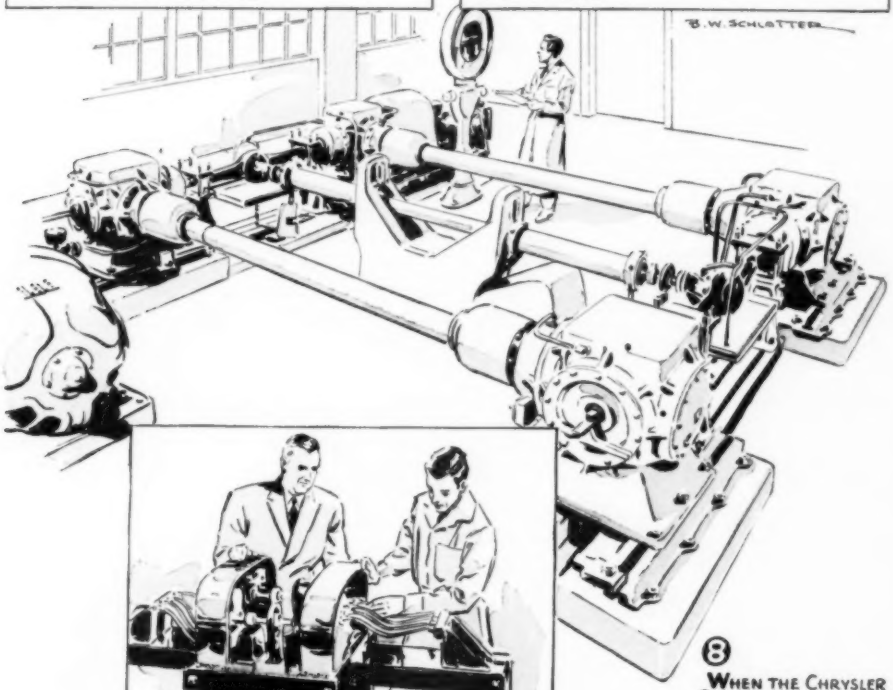
AS PRESIDENT OF THE ZEDER-SKELTON-BREER ENGINEERING COMPANY, HE HELPED DESIGN THE FIRST CHRYSLER CAR IN 1923

B. W. SCHLATTER



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WHEN THE CHRYSLER CORPORATION WAS FORMED, FRED ZEDER BECAME VICE PRESIDENT IN CHARGE OF ENGINEERING

9

TODAY, AT 55, HE IS VICE CHAIRMAN OF THE CORPORATION'S BOARD OF DIRECTORS AND DIRECTOR OF THE CHRYSLER LABORATORIES. HE IS CREDITED WITH MANY IMPROVEMENTS IN AUTOMOBILE DESIGN

America's Five Favorite Hobbies

By EDWIN TEALE

AMERICA is the hobby center of the world. More money is spent annually on hobbies in the United States than in any other country on earth. From old-fashioned whittling to polarized-light microscopy, a thousand and one spare-time interests provide Americans with relaxation and amusement. Seeking relief from the strain of an uncertain future, millions of persons, in recent months, have joined the ranks of the hobby-riders.

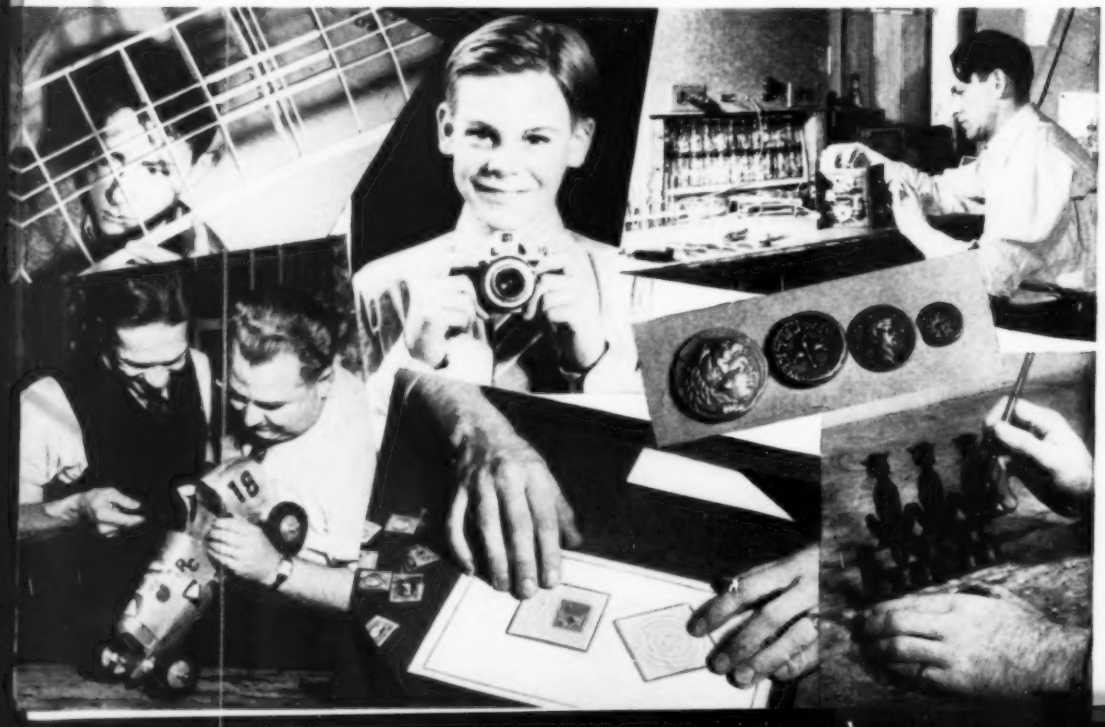
Supplying the needs of America's vast army of hobbyists has become big business. Factories with incomes of millions of dollars annually cater to the wants of men and women who are following specialized hobbies. Each week sees an increasing number of hobby columns in newspapers and hobby volumes on the shelves of libraries and bookstores.

Among all these infinitely varied avocations, which are the favorite ones? Which attract the most followers? Which represent the greatest annual money investment? What are America's five leading hobbies?

To find answers to these questions, POPULAR SCIENCE MONTHLY, during recent weeks, has been conducting an extensive survey covering individual hobby groups, manufacturers in the hobby field, national organizations devoted in various ways to the furthering of hobbies. On the basis of the number of persons engaged in the particular avocation and the amount of money spent by them during a year, the following five active hobbies emerged at the top of the list:

Photography,
Stamps,
Music,
Model Making,
Home Workshop.

Have you ever wondered how many Americans collect stamps or own cameras; how many people have home workshops or spend their leisure time operating model railways? On the pages that follow, you will find such information. For up-to-the-minute facts about the nation's No. 1 avocation—photography—turn to the next page.

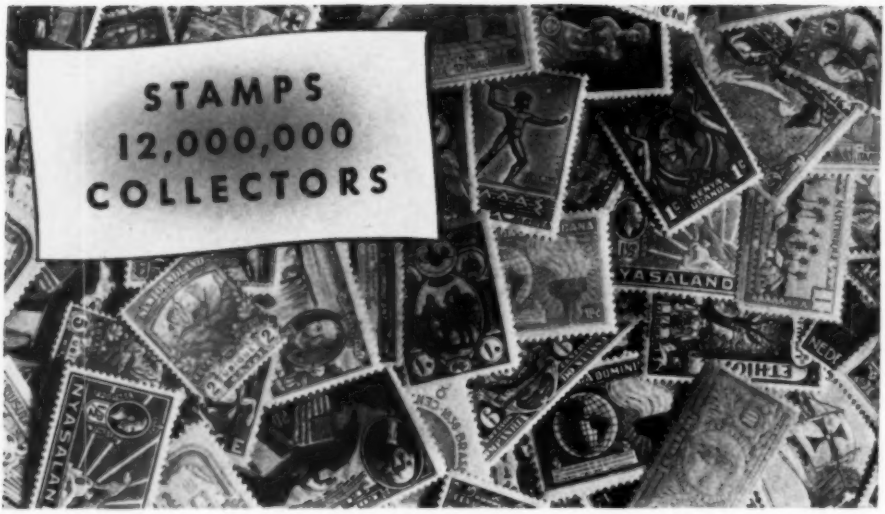


PHOTOGRAPHY 19,500,000 CAMERAS

There are 500,000 amateur movie makers in the United States, and 19,000,000 fans who go in for still pictures. Among the latter, box cameras outsell other types two to one

LAST YEAR, 19,000,000 amateur camera fans clicked their shutters 600,000,000 times to record still pictures in the United States. They spent, during that year, more than $100,000,000 for film, supplies, and new equipment. The simple box camera, stand-by of amateurs for decades, is still top seller in American photographic stores. In 1939, the latest year for which such statistics are available, box cameras outsold all other types two to one. Of the 1,500,000 new cameras purchased that year, approximately 1,000,000 were box outfits. Miniature 35-millimeter cameras represent only about one percent of those used by American amateurs. The film most widely in demand is No. 120. Most photographed object in America is reported to be Oscar, polar bear at the Rochester, N. Y., Zoo. Eastman technicians try out new films by photographing Oscar's white coat against a dark background.

Besides America's 19,000,000 still-camera fans, there are some 500,000 home-movie enthusiasts. Eight-millimeter movie film outsells 16-millimeter in this field and, in the production of America's leading maker of home-movie film, the Eastman company, Kodachrome leads black-and-white. More than 200 amateur movie clubs are active in the country. The number of still-camera organizations, counting both junior and adult groups, exceeds 9,000. There are about 5,000 adult clubs and approximately 4,000 school and junior photographic organizations in the country. New clubs are being formed at the rate of more than one a week. Nearly 100 such groups are active in the New York City area alone. There are camera clubs composed of doctors, of chemists, of Wall Street brokers, of telephone-company employes, of bankers, of a hundred and one other specialized groups. The largest photographic organization of the kind is one devoted to snapping railroad pictures. With headquarters in New York City, it has more than 15,000 members scattered in virtually every state in the union as well as in foreign countries. Smallest club is said to be a pictorial group with only eight members, four of which live in New York and four in Cuba. They get together for meetings at intervals of two or three years.



FIFTY MILLION DOLLARS a year, approximately, are being spent by the 12,000,000 Americans whose hobby is stamp collecting. The number of these enthusiasts, according to philatelic authorities, has zoomed from 2,000,000 in 1931 to six times that number in 1941.

During the Government's last fiscal year, the Post Office Department sold $4,000,000 worth of new stamps to American collectors. This sum represented an almost clear profit for the Government. In New York City, more than 175,000 school children have stamp collections. Issues from countries overrun by Germany are now in greatest demand. All told, there are more than 150,000 different kinds of stamps listed.

Many present-day enthusiasts are buying stamps as an investment as well as a hobby. A New York newspaper, a few weeks ago, carried an advertisement reading: "An entire lovely island, south shore, Massachusetts. Will consider exchange for North American stamp collection." At least 10,000 persons in the United States are following a budget plan of stamp buying to build up college funds for their children. There are, experts say, more than fifteen collections in the United States worth $1,000,000 apiece.

Six times as many Americans now collect stamps as in 1931. World events give the hobby new appeal

Experts use microprojectors and other elaborate equipment in examining stamps to make sure that collectors get what they pay for

MUSIC 10,000,000 AMATEURS

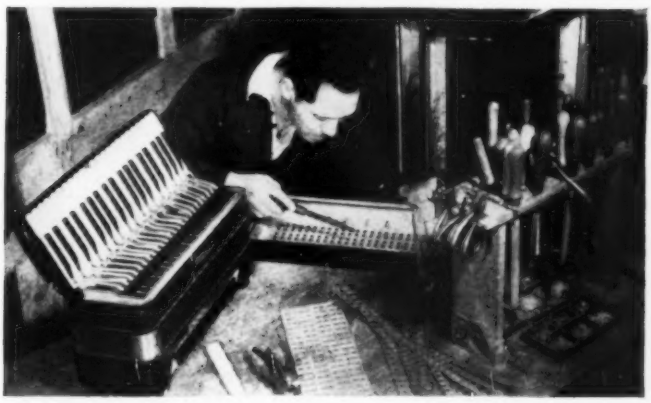
ACCORDING to conservative estimates, 10,000,000 Americans turn to music for a hobby. Musical avocations, during the past decade, have gained rapidly in popularity. In 1932, there were approximately 20,000 school bands in the United States. Now, there are 50,000. In 1932, the number of pianos shipped from American factories was 27,274; last year, it was 136,500.

When the first national high-school band competition was held in Chicago, Ill., in 1923, only 25 bands competed. Today, as many as 5,000 take part in the sectional and national competitions. School orchestras, with an average of about 25 players, number in excess of 40,000. Each year, between 3,000,000 and 5,000,000 school children study some kind of instrumental music. In 1924, when National Music Week was first observed, only 800 communities took part. By 1930, the number had reached 2,000, and by 1940, 3,000.

Shifts in popularity of instruments have occurred in recent years. The once-popular banjo has almost disappeared, while the accordion is riding a new high tide of favor. The finest accordions, costing about $1,000, contain more than 3,500 parts and require six weeks to make.

50,000 school bands keep young America tooting

It is estimated that from 3,000,000 to 5,000,000 of the country's school students are learning to play some musical instrument



Accordions are enjoying a great popularity now. The finest of these instruments cost about $1,000, contain more than 3,500 parts, and require six weeks to make

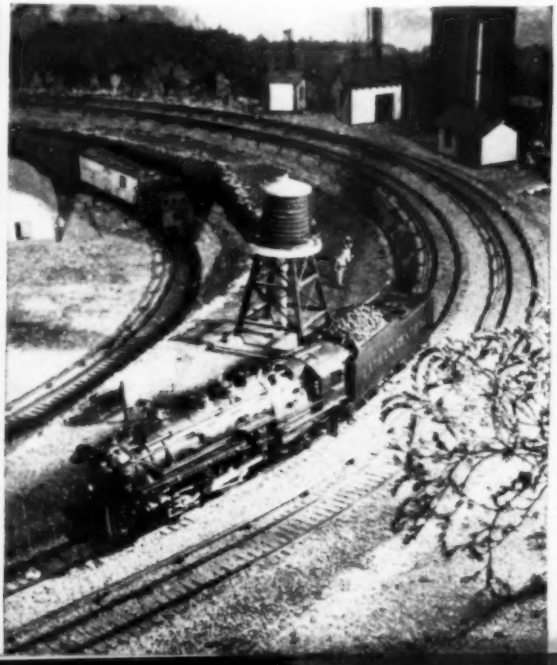
MODELS 2,250,000 MODELERS

There's no bottleneck in model-plane production. About 2,000,000 were made by amateurs last year

THE whine of midget gas engines, the whir of miniature plane propellers, the metallic chatter of model railroad trains provide music to the ears of more than 2,250,000 Americans. Last year, approximately 2,000,000 model airplanes were turned out by amateurs in the United States. Nearly a quarter of them were powered by gasoline engines. The other 1,500,000 depended on conventional rubber-band motors. In recent months, the trend in model-plane building, naturally, has been toward military ships. One eastern amateur has a fleet of 15 gas jobs, each equipped with its own power plant. Similar air-cooled engines are being used in streamlined miniature racing cars. Competitions between these mile-a-minute midgets have increased in popularity during the past year and a half.

In all parts of the country, model railroading is as active as ever. Lumping together the "tinplaters," who buy their equipment ready-made, and the "model railroaders," who make theirs to scale, there are approximately 250,000 miniature-train enthusiasts in the United States. Last year, they spent $11,000,000 for new electric trains alone. The average model railroader spends about $3 a week on his hobby. More than 100,000 of these hobbyists are said to have equipment that is worth $400 or more.

Miniature railroads have perennial fascination. Some enthusiasts buy their equipment ready-made; others build it. Outfits range from simple layouts to elaborate systems with hundreds of feet of track

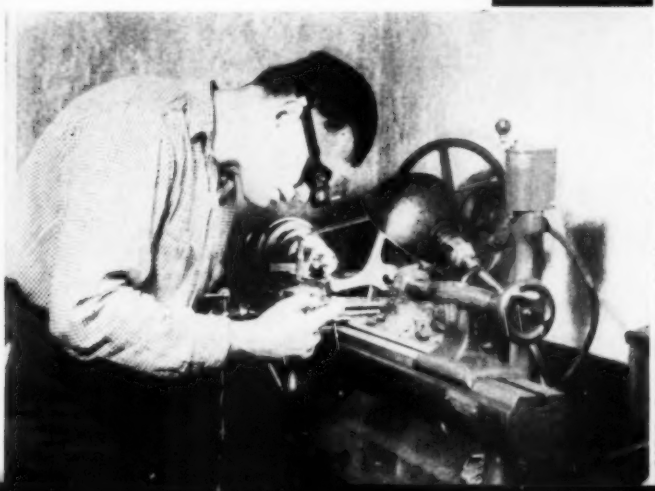


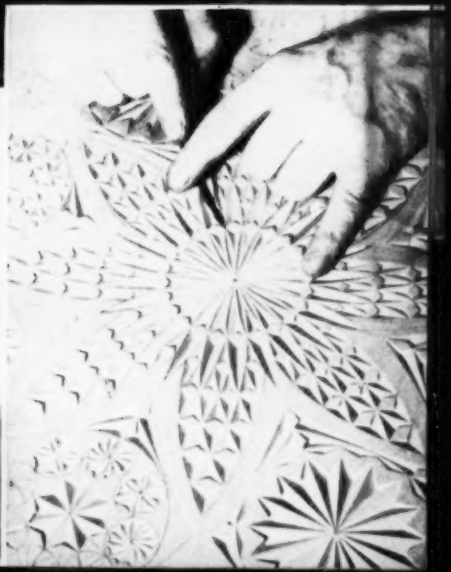
HOME WORKSHOP 2,000,000 SHOPS

IN 2,000,000 home workshops, American hobbyists are finding fun working with tools and making things of wood and metal. Stemming from one of the most time-honored hobbies of all, whittling, home craftwork has branched out in many directions. Approximately one in four shops, 500,000 out of the 2,000,000 total, are equipped with power tools. According to the estimate of one machinery manufacturer, home-workshop hobbyists in the United States install annually about $5,500,000 worth of new electric-driven machines. Approximately 400,000 of the home-workshop fans are fortunate enough to possess power lathes. The average amount spent in twelve months by the confirmed home workshopper on tools and materials runs between $50 and $100.

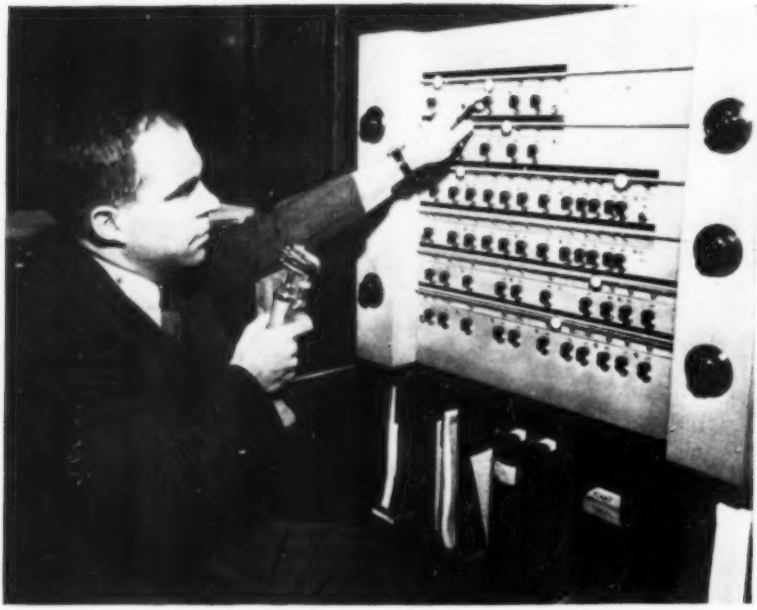
Both farm and city dwellers enjoy home workshops. A few years ago, when a leading farm journal made a survey of its readers, it discovered that 27 percent of all the farmers who replied to the questionnaire had home workshops and spent their leisure on craft projects.

Besides woodworking, carving, furniture-making, and metal work, there are numerous specialized branches of home-workshop activity. One of the leading variations of the kind is amateur radio. The 56,000 licensed amateurs in the country construct, operate, and repair their own wireless sets. They range from schoolboys to octogenarians. The youngest is 11 and the oldest 88. One amateur has a layout that cost $25,000 while scores of "ham" operators get along on a total investment of $25. Banded together in The American Radio Relay League, 26,000 of these amateurs help maintain communication when floods or storms interrupt telegraph and telephone service.





Amateur radio is an important branch of home-workshop activity, with 56,000 licensed "ham" operators. Wood and metal working rank high: there are some 400,000 power lathes in use by amateurs. Craftwork of many kinds combines artistic self-expression with the use of manual skills

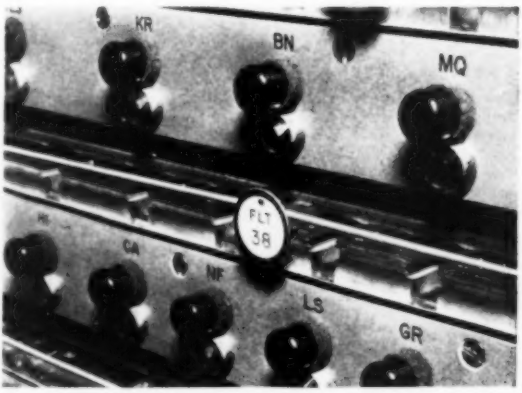


This signal board shows a TWA dispatcher the locations of all flights under his control

Block-Signal System Checks Planes' Positions

AN AUTOMATIC block system for commercial or military planes, developed by radio engineers of the TWA airway system, gives a flight dispatcher an animated picture of craft operating in any area under his control.

Ordinarily, dispatchers have depended upon radio reports from planes to fix their position. The new system, however, employs a series of tracks—each one representing one direction along an airway. Electrically driven worms move brass blocks, representing planes, along their corresponding tracks.



Brass blocks move along tracks according to flight schedules. At "check points," positions are verified by pilots' reports

As soon as a plane leaves a terminal, the miniature plane starts moving across the panel, its speed regulated in accordance with the pilot's flight plan. Slots along the track represent "check points" where the pilot is due to report. When a report is received, the dispatch-office radioman closes the "block," allowing the plane on the panel to pass on toward the next check point. If the pilot fails to report on time, however, the plane drops into a slot and rings an alarm bell. This calls for an inquiry from the flight superintendent, who puts the plane back on the track when the pilot radios his safe arrival. No plane can enter a "block" until it has been cleared by the preceding plane.

New Textile Research Brings You

BETTER CLOTHES

By DAVID M. STEARNS

TODAY you can buy rainproof clothing that looks like an ordinary cotton or linen fabric, is soft and pliable, and can be worn, laundered, and dry-cleaned indefinitely without losing its rainproof qualities. Even the flimsiest fabrics can be flameproofed at low cost. You can buy a velvet gown that will withstand hours of crushing and emerge without a wrinkle.

Before long there will probably be available a starchlike finish that, once applied, will last as long as the cloth on which it is used. A synthetic fiber already is being manufactured that has many of the desirable qualities of wool.

That is mentioning but a few examples of what chemical research has done for the textile industry and the textile-consuming public. Many of these products and developments which give you better clothes resulted from years of painstaking experiments, while others were developed from tests in which the chemists were seeking something else.

Take flameproofing, for example. A chemist in the Du Pont laboratories in Wilmington, Del., was trying to make a new plasticizer. He was working with urea, or carbamide, which is one of the recent products made from elements of coal, air, and water. Adding fuming sulphuric acid to one of his experimental mixtures, the chemist found that he had sulphamic acid.

This product had been known for years, but this surprise development showed the first practical method of producing it in commercial quantities.

Then ammonium sulphamate was made from the sulphamic acid, and this turned out to be just about the best flameproofing agent yet developed. Flameproofing agents had been used previously, but some stiffened fabrics to which they were applied, others spoiled colors, and some eventually dried and "dusted" out of the treated cloth, leaving it again vulnerable to fire.

Ammonium sulphamate does none of these

A scene in the New York laboratory of the Du Pont Organic Chemicals Department, Dyestuffs Division

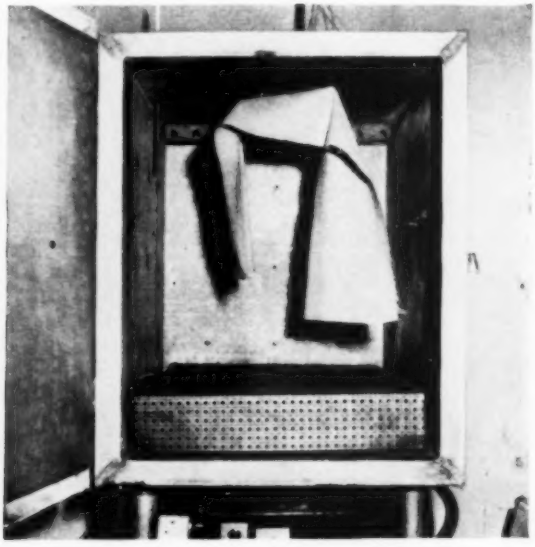
things. And because it is water-soluble, any laundry can apply it easily to dresses that might blow into a fireplace or over a stove, or to curtains to be used where there is a fire hazard. Workmen's clothing can be treated with it, or it can be applied to paper by painting or spraying. In fact, it is effective on almost any fabric and on most cellulose products.

Its application to clothing is simple. The ammonium sulphamate finish is dissolved in water. The material to be treated is soaked in this solution and then dried and ironed in the usual manner. Because of its water solubility, however, washing removes the chemical, and it must be reapplied after each laundering. Dry-cleaning, however, does not affect it.

Finishes based on ammonium sulphamate do not actually prevent a fabric from being destroyed by fire. Treated cloth held in a flame will be slowly consumed, but the moment the flame is removed, the cloth stops burning and there is no afterglow.

Flameproofing turned out to be but one use for sulphamic acid. It is useful in tanning leather, the ammonium salt is effective as a weed killer, and experiments are now

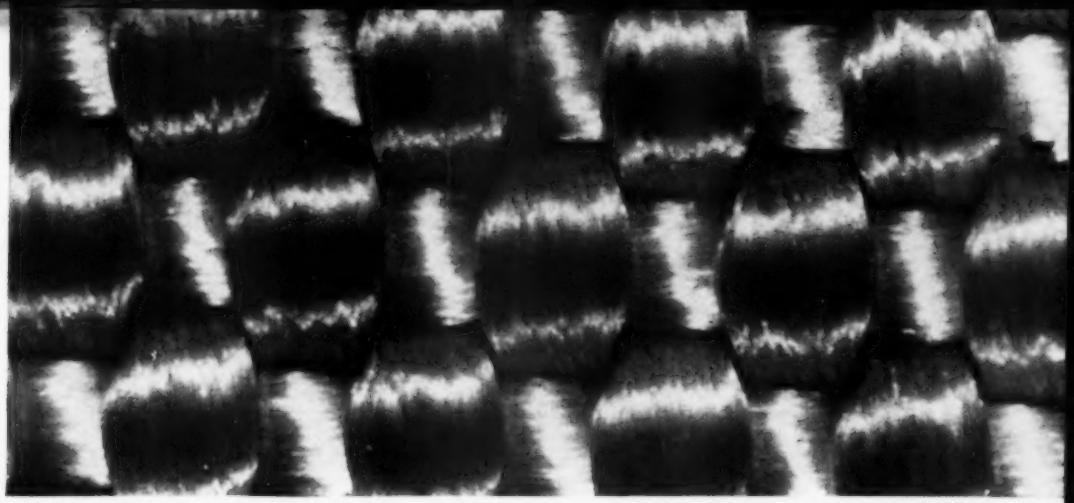
1. To test "Zelan" water repellent, the fabric is first soaked in a solution of the compound



3. Third step is baking in an electric oven. For best results, the temperature must be carefully regulated

2. The cloth is then hung on a frame and dried with fans at a moderate temperature, as below

4. And this is the effect: drops of water on a Zelan-treated fabric. Note how the cloth resists moisture



Magnified photograph of "Cordura" rayon sailcloth, showing continuous filaments of the synthetic fiber

Flameproofing fabric. The cloth is dipped into a water solution of the Du Pont "fire retardant"

After wringing out and drying, the cloth is put to the test along with an untreated piece. The flames . . .

. . . consume the untreated sample (at left); the other does not support combustion

under way to develop its fullest usefulness in this line.

The demand for this product is already so great that the Du Pont company has built a plant to manufacture it on a large scale. Not wishing to mislead the public into believing that it will be possible to hold a piece of cloth treated with ammonium sulphamate in a flame without damaging it, the product is sold by the manufacturers as a "fire retardant."

The development of durable water-repellent finishes for fabrics represents one of the latest and most important accomplishments of the textile chemist. Water-repellent finishes have been known for many years, but until the advent of "Zelan" durable water-repellent finish (known as "Velan" in England, where it was developed), all such finishes available in this country were removed by laundering or dry cleaning.

This is the first process in which chemicals used in making a fabric water-repellent are such that they act to form a compound with the fibers of the cloth. Because of the tight bond between Zelan and the fabric, the finish is highly resistant to both laundering and dry cleaning and retains its effectiveness throughout the useful life of the garment.

This finish must be applied to fabrics under carefully controlled conditions and accordingly is applied only in textile mills. Though it naturally adds something to the cost of clothing, its usefulness and popularity are shown by the number of garments now being manufactured of Zelan-treated fabrics. The U. S. Army recently ordered almost 2,000,000 garments of fabrics to which water-repellent finishes have been applied.

Collars on men's shirts that regain their stiffness each time they are laundered, and

To see how dyestuffs will stand up under washing, small skeins of yarn are dipped in the dyes . . .

. . . and then placed in glass jars containing various washing solutions. These go into a machine . . .

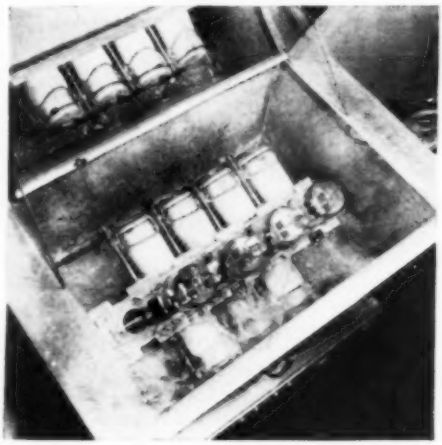
resist wrinkling, all without the use of starch, are another contribution of the chemists. These are made by inserting a layer of some thermoplastic such as acetate rayon between the two layers of cloth of which collars are made. The thermoplastics hold their shape as long as they are kept at ordinary temperatures. But when heat, say from an iron, is applied, they can be molded. So when the laundry irons your shirt collar, the wrinkles vanish and after the collar cools, the thermoplastic stiffens and holds the cloth in the desired shape.

Crushproof velvets and other crease-resistant fabrics are usually produced by applying any of a variety of chemical compounds to the cloth. Some form chemical unions with the fibers, others merely coat the surface. But the general result is to give them an elastic quality which makes them spring back to their original shape when pressure is removed.

Nylon, rayon, and similar synthetic products belong in any list of chemists' contributions to better clothing, and new uses for these synthetics are constantly being found. Just recently nylon thread for home sewing, by hand or on the sewing machine, was placed on the market. Its strength and elasticity allow garment seams to stretch without danger of breaking the stitches.

Rayon, one of the older synthetics, is now produced as a fiber that has certain characteristics formerly found only in wool. Like wool, this new "Fiber D," as it is called, has a high degree of permanent "crimp." It has been used successfully in carpets, draperies, and upholstery.

Dyestuffs are another important chemical



. . . called a "Wash-O-Meter," which sloshes them around in a water bath at a regulated temperature

contribution to textile users. In this field the chemists have been making constant progress, until today more than 2,700 kinds of dyes are being made in this country alone. Mildewproofing, shrinkproofing of certain fabrics, and many kinds of permanent finishes can be added to the list.

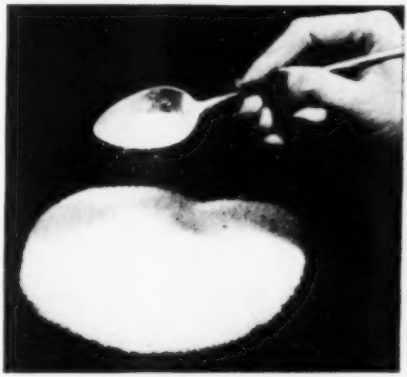
Not satisfied with what they have already produced, the chemists continue to spend millions of dollars every year on research. Right now they are seeking a means of shrinkproofing wool, and a permanent mothproofing finish. When they find them, they will go on to something else. You can be fairly certain that out of their test tubes will come still better clothes for the future.

Glass-bead traffic line on a California highway. Tiny spheres embedded in lacquer reflect the light

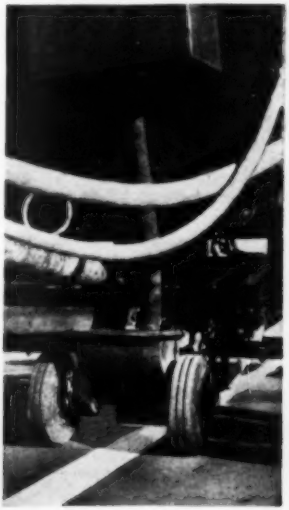
Beads Brighten Traffic Lines

TINY glass beads, held in place by white or yellow lacquer, are being used by California highway authorities to brighten traffic stripes at places where fog, curves, and hills obscure the vision of night drivers. Measuring as little as 1/100 of an inch in diameter, the spheres reflect headlight beams and return the color of the painted line, making the striping brighter and more effective after darkness falls.

To apply the beads, a striping machine is pushed ahead of a truck. A bead-dispensing hopper occupies a place directly behind the paint rig's spray nozzle. When the machine is in motion, its wheels turn a fluted cylinder in the hopper, which feeds the beads upon the wet lacquer. As the paint dries, capillary attraction draws it into interstices between the beads, firmly bonding them in place. As the line wears down, the uppermost spheres progressively become detached, but the reflection still is seen until the last are gone. Painted-bead lines are said to remain brilliantly visible twice as long as painted strips, and are self-cleaning, since traffic removes dust.

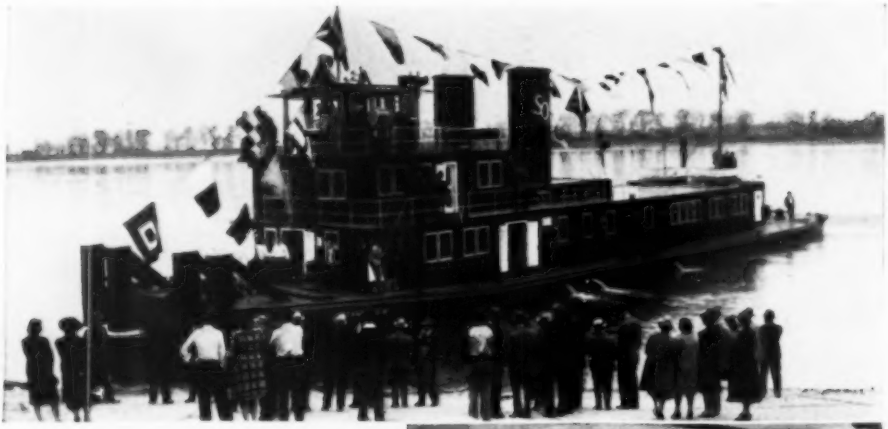


An ounce of prevention for night accidents. The smallest beads used are 1/100 inch in diameter



As the striping machine is pushed along the highway, beads are fed out evenly onto the wet lacquer from the hopper shown at right

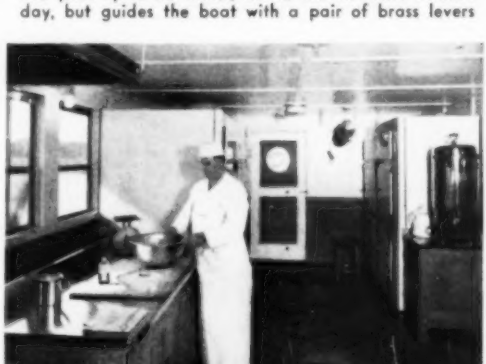
Old Man River Gets a Streamlined Boat



Old-time Mississippi River pilots would blink at the towboat *Stanolind A*, here nosing up to the shore at her home port

A NEWCOMER to Mississippi River traffic, the twin-screw towboat *Stanolind A*, offers a striking contrast to the stern-wheel type long in use for pushing lines of barges lashed together. The 1941 model transmits 1,200 horsepower to its 76-inch propellers, of tunnel type for service in shallow waters. Stubby "knees" at the bow push six barges, loaded with 2,400,000 gallons of Standard Oil Company of Indiana products, against the current. Deck house, pilot house, and stacks are low-lying. The pilot house contains no wheel for the pilot to spin. Instead, he guides the 144-foot boat with a pair of long brass levers. A battery of high-powered searchlights, operated by overhead controls in the pilot house, help him to keep in the winding channel. Pilot and engineer can converse easily over loudspeaker telephones, since the roar of the two 600-horsepower Diesel engines is deadened with a Maxim silencer and soundproof material on the bulkheads. Seven commodious staterooms accommodate the crew, whose meals are prepared in a roomy galley equipped with an oil-burning range, two electric refrigerators, and an electric coffee urn. Thirty-five feet in the beam, the boat draws $8\frac{1}{2}$ feet of water.

The pilot spins no wheel, as he did in Mark Twain's day, but guides the boat with a pair of brass levers



The crew's meals are cooked on an oil-burning range, and the large galley has two electric refrigerators

Want a Shine?

LIKE BOOTBLACKS for Gargantua, workers on the Douglas B-19, largest plane ever built, dust and polish its wings and fuselage every day. More than 8,500 square feet of metal are being brought to a brilliant gleam, in preparation for the great craft's emergence from its construction hangar. It has a wing spread of 212 feet and will be able to fly more than 7,700 miles without stop, with a total weight of 82 tons. This is the new U. S. Army plane that could fly from the American mainland to Europe, drop a load of bombs, and return to its base without having to refuel.

A Home

TO YOUR ORDER IN

50 Hours

SIX eight-hour working days, plus a couple of hours, after the contract is signed your new home will be ready for occupancy. That's the guaranty of Hal B. Hayes, 29-year-old California builder, who has developed his own system of mass-producing houses with pre-cast concrete.

Hayes's houses are not shacks, either. They are complete with landscaping, lighting and plumbing fixtures, shades and screens, and paint or paper on the walls.

To achieve this remarkable speed, Hayes turns out walls, roofs, and partitions at a "factory." Door and window frames, conduits for wiring and plumbing, and bars of reënforcing steel are laid out in their proper positions and the concrete is poured into forms around them. That takes only a few hours.

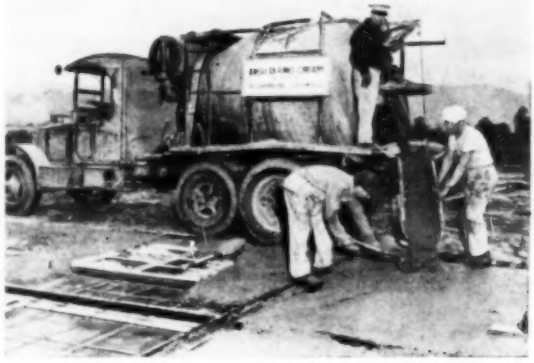
When they have dried, the parts are loaded on a truck and trailer by a crane and hauled to the building site. The crane goes along to unload the pieces and hold them in position while workmen bolt them together. This house is ordinarily completely set up within three days; in a demonstration a three-room-and-bath unit was erected in 23 minutes.

Best of all, the completed dwellings are proof against moisture, termites, fire, and earthquakes. According to Hayes, his system could be used to produce bombproof shelters that would conform to present British requirements for such structures.

He has already turned out 100 homes, and now he is working on an order for 1,000, to be built in Venezuela.

1 Before pouring the concrete for a wall or roof, workman oils slab on which it will take shape. This makes it easier to remove wall when it dries

2 Hal B. Hayes, inventor of the system, puts window form on slab, making ready for pouring of a living-room wall

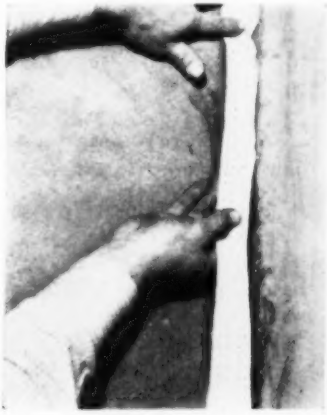


3 "Construction" begins. With three mixers, an eight-room house can be poured in 30 minutes. It can be erected ready for occupancy in five work days

CONCRETE CONTAINING PUMICE as a major ingredient is used in building these pre-cast houses, because it is light but strong, nails can be driven into it, it can be cut with a saw, and it has greater flexibility than orthodox concrete, and good insulating qualities. The pumice comes from the Mojave Desert.

PRE-CAST HOUSES can be purchased in any of a dozen models, five to eight rooms. An average house, with two bedrooms, can be built for $3,000, allowing $400 for a site, and financed for as little as $150 down, $15 a month. A special method of vibrating the forms while concrete is being poured makes it possible to form kitchen sinks, with drain and splash boards, in a single casting of concrete, with a tile-like finish. At left, first pre-cast house with shingle roof. It is a two-bedroom home owned by Mr. and Mrs. Paul Bergman, of Burbank, Calif. It is decorated with paper, applied directly to concrete walls, and it has a landscaped garden.

4 Combination tower and boom is the real secret of speed in setting up the house. It can pick up a ten-ton load, and ease it down 60 feet away without chipping a corner



5 Porous Scotch tape is glued on inside corners. Outside, the joints are grouted with cement

6 Here is the first pre-cast home to be completed with 4½-inch concrete roof. It is a seven-room house in North Hollywood, Calif. It is shown ready for windows and doors

Highballing the Hotshots

This Mohawk locomotive drags the New York Central's hotshot Merchandiser on its fast overnight run from New York to Buffalo

FREIGHT SCHEDULES list her as the Merchandiser, but all along the main line of the New York Central Railroad they call her the Moneymaker. Before the glare of her searchlight has painted the sky, loading platforms at Rensselaer, Utica, Syracuse, and Rochester have been prepared for her reception and cars laden with rush goods are on the sidings. She roars through the Mohawk Valley flats at an authorized speed of 65 miles an hour, and freight which leaves New York after the end of the business day is in Buffalo less than eleven hours later, before another day's business begins.

Nine dollars a train mile is the revenue from the Merchandiser. Normal passenger-train revenue is $2 a train mile. Simple mathematics gives these hotshot freights precedence over most passenger trains. The big new Mohawk-type locomotives and steel cars with high-speed running gear and special brakes enable the Merchandiser to utilize every advantage her prestige gives her.

Work on hotshot freight gains impetus as other lines of business are closing for the day. Until about 5:30 p.m. a leisurely atmosphere envelopes the Merchandiser's loading platforms at St. John's Park in New York. Then things suddenly begin to hum as the trucks laden with last-minute ship-

At St. John's Park in New York City, stevedores unload last-minute cargo from shippers' trucks . . .

. . . and stow it in special box cars designed to hold the rails at speeds above a mile a minute

EDWIN H. BROWN and RALPH MORSE, writer and photographer, rode a fast overnight freight train between New York and Buffalo to bring you a word-and-picture story of steam and steel. It's today's big news in American railroading.

New equipment and hand-picked personnel help make possible the fast schedules and efficient handling of the hotshot freights

ments roll in, bringing goods that will be on the counters of upstate department stores in the morning. The transfer of goods is made with swift precision and the swarming platforms suddenly gape emptily as railroad police and yard crews check car seals and brakes.

With smooth docility the Buffalo hotshot is off, rumbling northward on the elevated tracks behind an electric switcher. A few more cars are picked up at the Thirty-third Street yards and next comes Harmon, where the change to a steam locomotive is made. It is waiting there on a parallel track, and the engine crews change places, swinging from one locomotive to the other without touching foot to ground. It takes five minutes to change engines.

The number of the steam locomotive has been chalked on the edge of the platform, the last of a series of such numbers. That is for the convenience of the conductor, who notes it in his wheel report as the train whips past with gathering speed. It saves a half-mile trip along the tops of swaying cars.

The next stop, Rensselaer, across the Hudson River from Albany, marks the end of the Hudson Division. A new crew takes charge there. A few hours later the men who took the Merchandiser out of St. John's Park will swing aboard a southbound train

When a car is loaded, it is sealed with a leaded metal strap which will break if tampered with

A yardman couples cars, guiding the switch engine, perhaps 30 cars away, by lantern signals

(Continued)

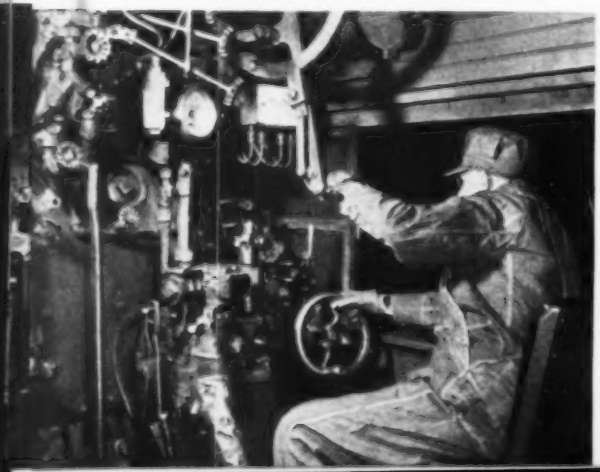
Engineer R. E. Bloum takes control of an electric engine that hauls the train out of the city

Beside him sits brakeman R. J. Bowen, calling out the colors of the block-signal lights . . .

. . . while fireman Frank J. Shotto has nothing to do on this part of the run except pull the whistle cord

At Harmon, N. Y., the big Mohawk steam locomotive is waiting. As the electric pulls up alongside it, the crew steps across without touching the ground. Engines are changed in just five minutes

Now in the steamer's cab, engineer Bloum opens the throttle as the long train races up the Hudson . . .



. . . while the fireman checks up on his fire and the 250 pounds of steam needed for the run

and complete their night's run in time to have breakfast in New York.

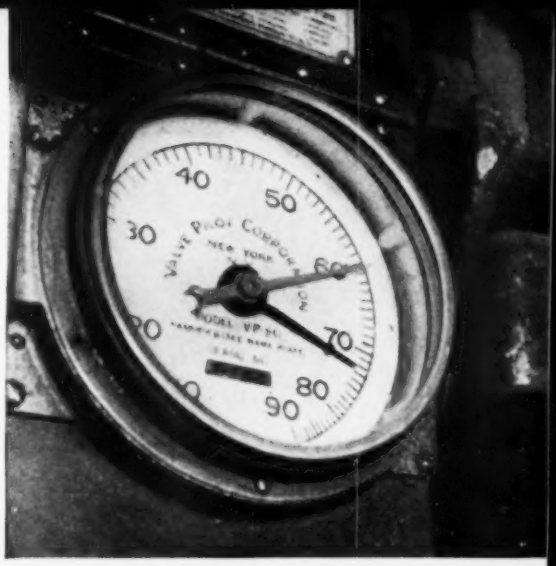
The Merchandiser heads west with a pusher engine to boost her over the Albany hill and settles down to the run through the Mohawk Valley. Cars are dropped at Utica, Syracuse, and Rochester, and other cars are added. In the earliest glimmer of dawn the switch points of the Buffalo yards are clicking underfoot. Early commuters step back on the platform as the grimy Merchandiser rolls through the passenger terminal spewing soot. A half-mile beyond she slides to a stop at the Clinton Street freight depot, 21 minutes ahead of schedule—but not too early for the trucks, already lined up by dozens, waiting for the hotshot freight.

More than 50 such trains make nightly runs in the United States. Every night the rails of the Erie; Delaware, Lackawanna & Western; B. & O.-Reading-Jersey Central; Burlington; Cotton Belt; Union Pacific; Southern Pacific; Pennsylvania; Southern, and half a dozen other systems sing to the rhythm of the great trains of 50 cars or more rushing through the dark.

They are the railroads' answer to truck competition and they are making the truckmen hustle for their money. Except for the silk trains and a few which were put on to handle fruit and other perishable freight, the railroads had become pretty complacent about their freight business. Then, in the early years of the depression, they suddenly realized that the less-than-carload lots were being stolen from under their noses by the truckmen. The Southern Pacific was the first to do something about it, inserting a car or two of freight on a money-losing passenger run. The volume of freight grew and the road soon was running a freight train with a coach or two tagged on.

The New York Central's Merchandiser, with its nightly run of 429 miles, is typical of the new freight handling. The train was put on in 1934, in the depths of the depression, replacing a banana train. The banana train left New York too early, and it took too long to make the run to Buffalo. Most shipping of the kind handled by the hotshots is last-minute shipping. The goods are got out shortly before closing time, and should be delivered early the next day.

With new and more powerful locomotives and freight cars which were built for speed, the railroad was able to cut down the running time and delay the start until after closing time. Streamlining the Twentieth Century Limited, the road's crack passenger train between New York and Chicago, helped. That train was put on a speedier schedule and the Merchandiser ran on the Century's former time to Buffalo with the passenger train clearing the way for it.



Slowly the finger of the speed gauge creeps around the dial to 60. The darker hand shows reserve power

It's hot in the rocketing cab. Shotto takes a swig from the oil can which serves as a bucket for water

At Rensselaer, a new crew takes over. Bloum checks watches with the new engineer, reports on the engine

(Continued)

CREW

Since no old-fashioned caboose could stand the pace, the rear-end crew rides in a rebuilt passenger car

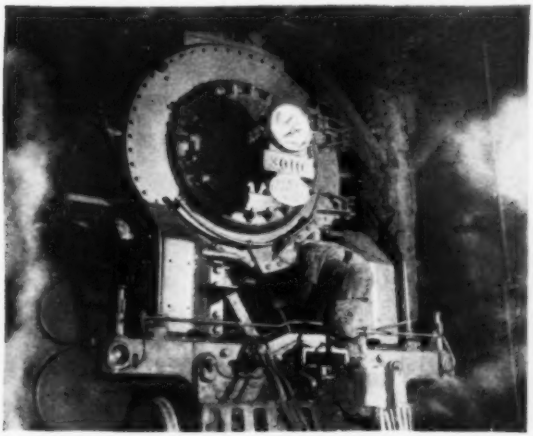
When another train is met, the brakeman looks it over to see whether it has any "hot boxes"

A lantern signal passes the information to the crew of the other train, which returns the favor

At every stop, train crew and yard crew check all the journal boxes and air-hose connections

Working in the "shack" throughout the run is the conductor, who must report on all cars by number

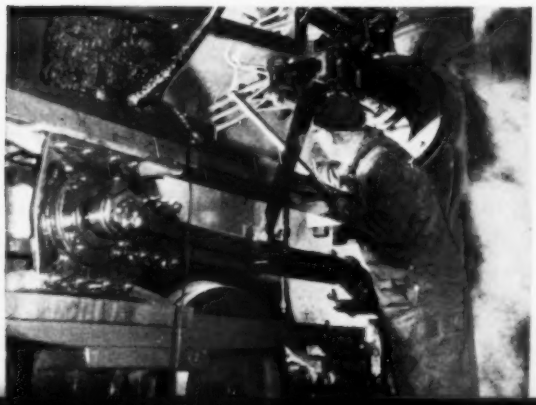
In the gray dawn, the Merchandiser rolls into the yards at Buffalo, completing its 11-hour, 429-mile run



Still steaming, the locomotive gets a thorough inspection in a roundhouse at the East Buffalo yards

If a bearing needs replacing, mechanics remove the big drive rod with crowbars and wrenches

Tapping with a hammer at vital joints, the inspector can tell how parts are standing the high speed



After a bath from an electric washing machine, the giant locomotive is ready for another run

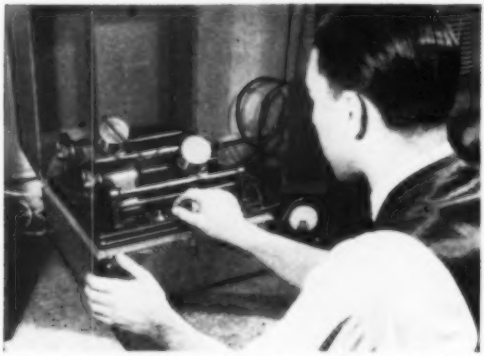
Radio Spies Are Trapped by Direction Finders in Prowling Motor Cars

SPY-OPERATED radio transmitters don't stand much chance of remaining undetected under the new set-up of the Federal Communications Commission. Direction-finding units in automobiles, fixed listening posts at 200-mile intervals, and ten long-range direction-finding stations now keep a 24-hour watch over ether activities in the United States and its territories. The mobile units are particularly effective for tracing illegal stations after their general location has been established by the fixed stations. Two of them, for instance, prowling about an area containing an illegal station, can get a number of direction lines on the station. When these are drawn on a map of the locality, they point unerringly to the transmitter.

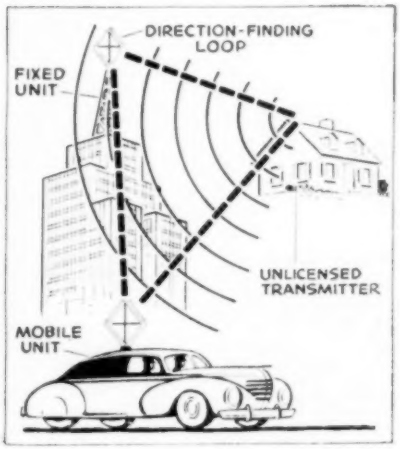
To handle the illegal stations which have sprung into operation with growing defense production, the F.C.C. recently increased its field force from fewer than 200 to almost 600 engineers and operators. This is a small staff for checking up on and recording code conversations on the air, foreign-language broadcasts and conversations, in addition to routine work. But last year more than 1,000 illegal stations were tracked down.

Radio detective in a car turning a loop antenna to find direction of maximum strength of illegally sent signals

Listening in to suspicious messages, an F.C.C. engineer writes what he hears, as possible evidence of espionage



Foreign-language broadcasts are recorded, and then translated. Records are made of cipher messages, too



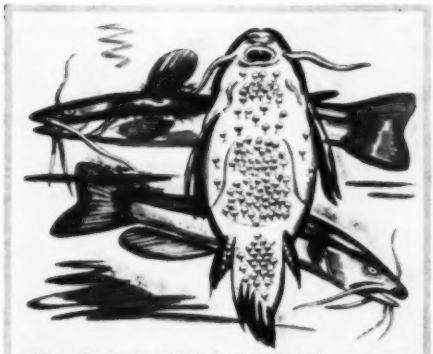
How mobile and fixed direction-finding units coöperate in locating an illegal transmitter

Un-Natural History

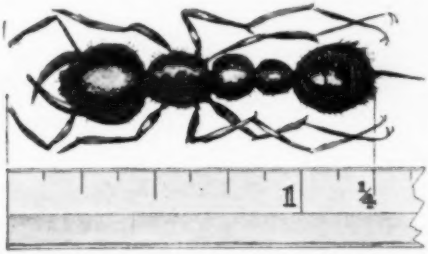
BY Gus Mager

A DENIZEN OF BRAZIL, THE **GOELDI FROG**, CARRIES HER EGGS IN A KNAPSACK! A FOLD OF SKIN OVERGROWS THE EGGS UNTIL THEY'RE DEVELOPED, WHEN IT SPLITS AND THE BROOD FALLS OUT!

IN ADDITION TO HIS FAMILY, THIS BRAZILIAN **TOUCAN** HAS TO SUPPORT A TREMENDOUS SCHNOZZLE! FORTUNATELY IT CONSISTS MAINLY OF AIR CELLS, SO IT IS NOT SO HEAVY AS IT LOOKS!

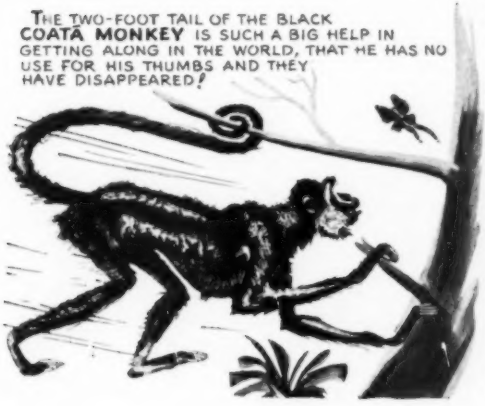


THE **FLAT-HEADED CATFISH** LAYS ITS EGGS ON THE RIVER BED AND THEN RUBS THEM INTO CUPLIKE CELLS ON ITS BELLY, WHERE THEY ARE NOURISHED BY ITS BLOOD UNTIL THEY HATCH!



WORKERS OF A GIANT SOUTH AMERICAN SPECIES OF ANT ARE AN INCH AND A QUARTER LONG! MOST PRIMITIVE OF ANTS, THEY STILL CARRY A STING, WHICH HIGHER FORMS HAVE LOST!

THE TWO-FOOT TAIL OF THE BLACK **COATÁ MONKEY** IS SUCH A BIG HELP IN GETTING ALONG IN THE WORLD, THAT HE HAS NO USE FOR HIS THUMBS AND THEY HAVE DISAPPEARED!



MILU DEER—ORIGINALLY OF CHINA—BRAY LIKE DONKEYS AND TROT LIKE HORSES! THEY HAVE TAILS LIKE MULES AND HOOFS LIKE COWS! THE CHINESE WEREN'T EVEN SURE THAT THEY WERE DEER!

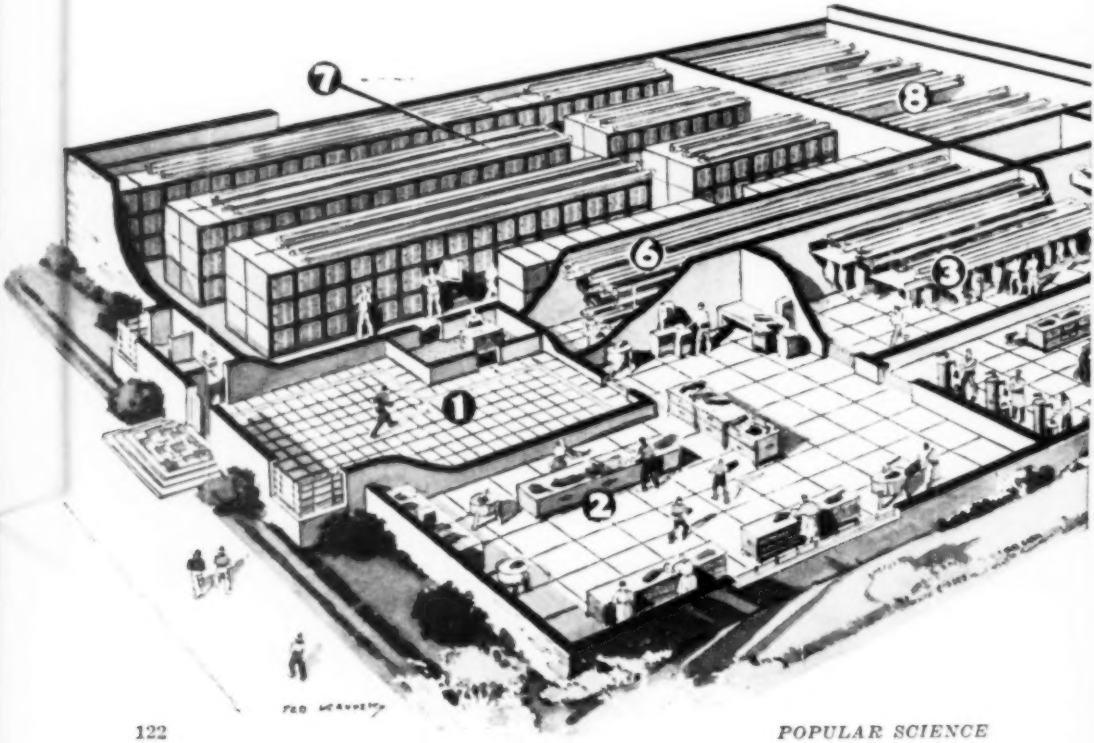
Quick-Freeze Your Food For $10 a Year

A NEW $35,000,000 industry which boasts it is saving a total of $50,000 a day for 1,250,000 American families is one of the good things that the country got out of the late unlamented Depression. It is the cold-storage-locker system for preserving foods, the invention of a group of financially hard-pressed but bravely imaginative farmers of the Pacific Northwest, who saw no reason why they should continue forever to sell their livestock and their crops at rock-bottom at slaughtering and harvest time, only to buy the same goods back as food at four or five times the price a few months later.

There were practically no locker plants in 1933, but there are 3,200 of them now. Fifty more are being built every month. They range in size from plants of 50 lockers, to plants of 2,000. Each locker holds about 200 pounds of foodstuffs. It is estimated that each locker saves its renter from $30 to $100 a year in food costs.

The locker plants are cold-storage plants in which food is first "quick-frozen" at ten or more degrees below zero F., and then stored at a steady temperature of from zero to 15 above zero until needed.

The quick-freezing process is the secret of the plants' success. Frost, which is a slow-frozen formation, destroys vegetables and fruits, making them watery and tasteless, and ruining their firmness of texture, while quick-freezing not only avoids injury to the food but in the case of peas and spinach actually improves their color and texture. The reason is that when freezing occurs slowly, ice crystals form inside the cells of the fruit or vegetable and continue to grow, sending out needlelike points, until finally the cell walls are pierced and the vital juices drain out. With "quick freezing" the sudden plunge to extreme cold causes only minute ice crystals to form and the cell walls remain intact.

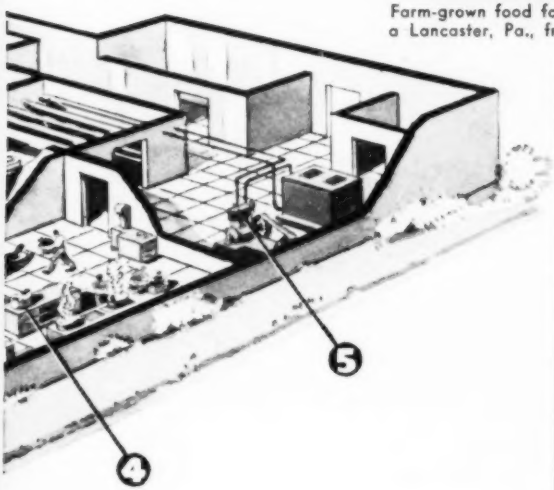


By
BARRETT
McGURN

Users of the lockers store away large quantities of beef, pork, and wild game in January, February, and March; sea foods in March and April; peas, asparagus, strawberries, and other early fruits and vegetables in May and June; and so on, around the calendar as various foods come in season.

Keeping the foods until needed, the locker renters have fresh corn on the cob and strawberry shortcake at Christmas, snap beans at Easter, and ripe peaches during the spring thaw. Besides providing out-of-season luxuries such as these, the lockers have given many of their users the less spectacular but

Farm-grown food for his family, quick-frozen and stored in a locker at a Lancaster, Pa., freezing plant, saves this farmer up to $100 yearly



A typical frozen-food locker plant, designed by a pioneer in the field, is shown here. Foodstuffs are brought to the main lobby, processed, frozen, and then placed in lockers until the owners call

Community Cold-Storage Plant

1 The lobby and office, where foods are brought in and registered.

2 Cutting room. Here steaks, chops, and other cuts are prepared.

3 Chill and aging room, where fresh-slaughtered animals are hung up.

4 In the processing room, vegetables are scalded, meats are sausaged, vacuum-packed, or smoked.

5 Machine room, where motors drive the compressors and pumps.

6 The quick-freeze room that readies all food for storage.

7 Locker room, where goods are stored at near-zero temperatures.

8 General storage room, for bulk foods and materials.

When a locker owner wants some meat sliced from a quick-frozen cut, an electric cutter resembling a band saw is used. The same tool is also used to process the meat before quick freezing

Meat products to be sold commercially are placed in latex bags which are sealed after the air is exhausted

far more important blessing of a year-round balanced diet, often for the first time.

Although several cold-storage methods had been tried before, the use of the locker plants really got under way around Sioux City, Iowa, in about 1933. The Middle West took quickly to the idea. Lately the South has taken it up with enthusiasm, leaving only the Atlantic seaboard comparatively undeveloped.

Promoters of the locker plants say that a family of five can save as much as $130 a year on its meat bill alone. Figuring that the family would normally buy 1,000 pounds of meat at a retail price of 29 cents a pound, the promoters say the family can cut the bill from $290 to $160 by buying the same meat in bulk at 14 cents a pound, paying $10 to have it butchered, cut, wrapped, and frozen, and $10 for the rental of a locker for a year.

Knowledge about the quick-freezing and care of foods has developed rapidly with the rise of the movement. Fresh-killed carcasses now undergo a series of carefully prescribed treatments. Each of the locker plants is a miniature packing plant, and at most of them butchering, cutting, grinding, sausage making, pickling, smoking, and other methods of preparing meats are done by a full-time butcher.

When carcasses are brought to a plant by locker users, the plant attendants hang them up in chilling and aging rooms for a time, where the body heat is permitted to escape completely in air at 33 degrees F., to ripen the meat and make it tender.

After aging, the meat is cut into chops, steaks, and roasts, ground into hamburgers or sausages, or cured according to the owner's instructions. The cuts are wrapped in moistureproof parchment or oil paper and carefully sealed. Without such precautions rapid discoloration and dehydration would occur. The meat is then subjected to the quick-freezing process, remaining at ten degrees below zero for from 12 to 24 hours. The packages are now ready for the locker.

With the exception of the vegetables that can be eaten raw, such as celery, lettuce,

radishes, onions, and cucumbers, and pears, almost every other kind of fruit and vegetable can be frozen successfully. Like the meats, the vegetables and fruits have to be prepared for storage. It is impossible to store any vegetables satisfactorily unless they are first well blanched (scalded), it was found. They are placed in water near the boiling point for from 30 seconds to seven minutes. This arrests the action of ferments, sets the natural color of the product, and makes packing easier.

Fish, too, need special care. They are first frozen and then dipped in cold water. This forms a protective glaze of ice which prevents shrinkage. Wrapped in moisture-proof paper, they will keep nine months.

In the locker rooms temperatures of ten degrees above zero have usually been held, but there is a trend now to temperatures as cold as zero. Enzymic and bacterial action are greatly slowed at 15 degrees above, it has been found, but it is not until zero has been reached that these actions are completely dormant. When the food is taken out of storage the fruits and vegetables are used immediately on thawing, as the frozen foods are not sterile. And contrary to early beliefs, no foods may be thus stored for longer than a year; few for that long.

A locker-plant operator places new foods on racks in a holder. The overhead hoist will lower them all together into the quick-freezing chamber in the floor

The locker patron walks into the cold locker room in 99 percent of the plants. Some people object to exposing themselves to the cold, while others suffer from claustrophobia when the door of the locker room is shut behind them to avoid warming the chamber.

To meet objections of this sort, Roy W. Smith, of Newark, Ohio, invented a locker room now known as the "Polar Chest." With this type the patron remains at all times in a warm room. The lockers are chests whose tops form the floor of the room entered by the patron. With a small 1½-horsepower crane, the patron pulls his locker up out of the floor. This room makes good use of the principle that cold air is heavier than warm. The cold air hangs down in the pit when a chest is raised, whereas it spills out every time the door of one of the walk-in types is opened.

Another development is the "Polar Wheel," with the lockers mounted on a huge wheel. The patron dials for his locker, the wheel swings until the locker faces a door. The patron opens the two doors and can take what he wants from his locker without entering any chamber.

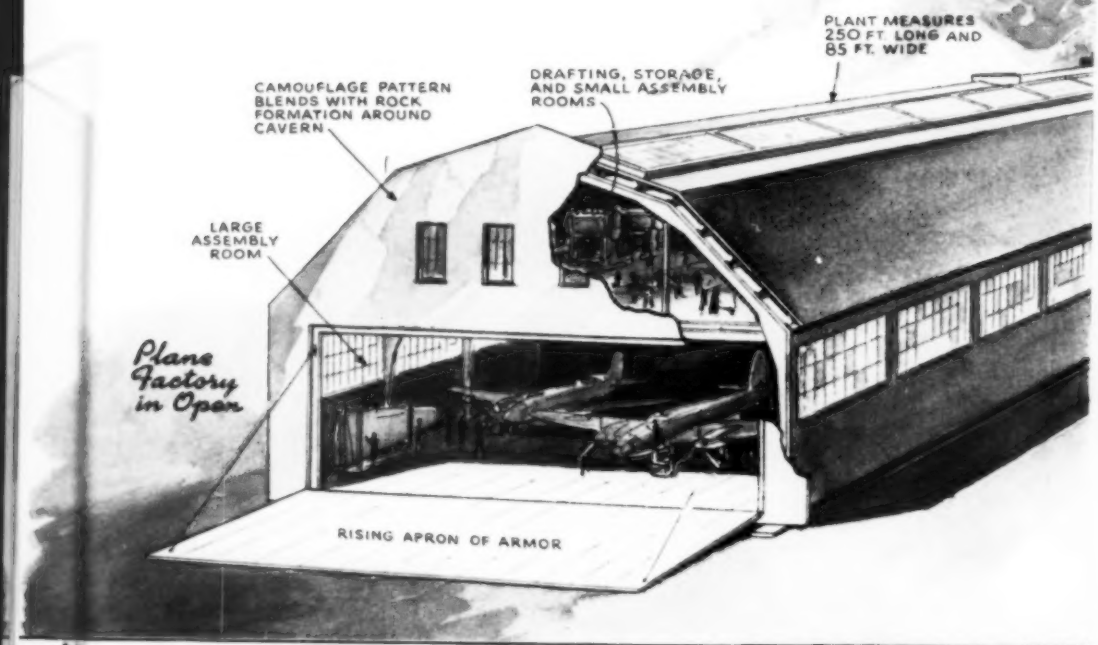
Experts in the locker-plant field estimate that the country could make use of 14,469 of the plants. The greatest proportionate increase in present facilities would be in the East, with New York going up from six plants at present to 1,282, and Pennsylvania going from its present 33 to 980.

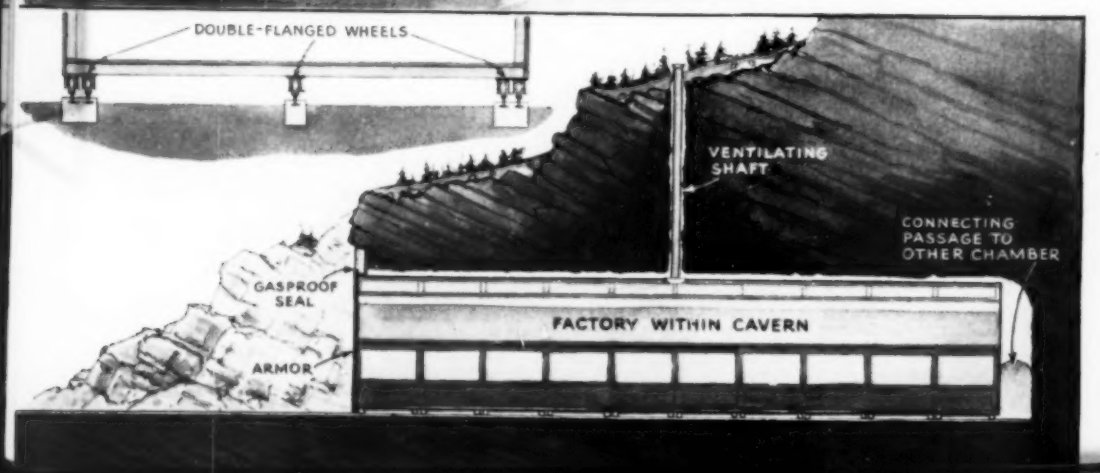
In this plant, the lockers, raised by electric cranes, form the floor of a reasonably warm room where callers can gain access to their goods without being exposed to the extreme cold

Bombproof Plane Factories

ROLL INTO MOUNTAIN SIDE

Raid Shelters for Assembly Plants: A Swiss Inventor's Solution to the Problem of Protecting Production


PLANT MEASURES 250 FT. LONG AND 85 FT. WIDE
DRAFTING, STORAGE, AND SMALL ASSEMBLY ROOMS
CAMOUFLAGE PATTERN BLENDS WITH ROCK FORMATION AROUND CAVERN
LARGE ASSEMBLY ROOM
Plane Factory in Open
RISING APRON OF ARMOR



Disappearing airplane assembly plants. One is shown operating in the open, the other hidden in the hill as for an air raid

AIRPLANE FACTORIES that literally run to shelter from raiding bombers have been invented by Antoine Gazda, noted Swiss armament designer, and erected at undisclosed places in Switzerland by the Pilatus aircraft concern as a national-defense precaution. A typical installation consists of a pair of twin assembly plants, normally standing in the open where their total of 360 workers enjoy natural sunshine and fresh air. At an air-raid alarm signal, however, a "motorman" enters a control cabin at the rear center of each plant's upper floor. He swings a switch handle, and the entire 1,600-ton factory rolls ponderously on electric-powered wheels into a cavern in a mountain side, completing its strange journey in about twenty minutes. Only its front remains exposed, and steel armor covers this end.

Meanwhile, workers reconnect quick-change electric and plumbing fittings to mains within the cavern, and attach a ventilating tube whose intake is hidden. Then the plant resumes full operation under artificial-daylight lamps. In case of a poison-gas attack, the front portal can be hermetically sealed, and fresh air drawn in through the ventilator is filtered and purified. When danger has passed, an "all clear" signal from observers brings the factory out into the open again.

Citrous Groves Cleared by Tractor-Drawn Rock Picker

Back-breaking work of picking up stones and hauling them from groves is done away with by this machine

A TRACTOR-DRAWN rock picker, invented by William Teucher of Claremont, Calif., clears citrous groves for less than a third the cost of hand labor. A sloping horizontal blade at its front (right, in picture) skims beneath the ground's surface, guiding earth and stones to a sievelike, shaking platform that returns the soil. Rocks continue to a bucket elevator that drops them, through a spout, into a dump truck moving alongside. A gasoline motor powers the picker.

A wearer of open-toed shoes tries "gloves" to save her stockings

"Gloves" for Feet, Transparent, Keep Out Cold and Wet

WET OR COLD feet are avoided with "foot gloves" of transparent, flexible, and waterproof material. Sold in packages of eight pairs, they may be put on before the shoes, as at left, or worn between shoes and overshoes. The maker recommends them to fishermen, hunters, and participants in winter sports; to policemen, firemen, and mailmen; and to women who wear open-toe shoes, or who wish to protect footwear.

The Old Army Mule Takes Guns Where Wheels Won't Go

IN SPITE of mechanization, the Army mule still has work to do. Part of it is carrying the latest type of 75-mm. howitzer in rough country where wheeled or tracked vehicles would be helpless.

This gun breaks down into six pieces for transportation. One mule carries the barrel, another the wheels, and the other four loads are the recoil mechanism, base frame, tailpiece, and breech of the gun. Five more mules are burdened with ammunition loads, and the twelfth carries the "pioneer pack," consisting of such tools as an ax, saw, shovel, flares, and emergency rations. The last animal in the 13 comprising each company is ridden by the crew captain.

The 98th Field Artillery (Pack) Battalion at Fort Lewis, Wash., where these pictures were taken, has 500 mules ready to take to the hills with guns and supplies on their backs. And the "muleteers" of the outfit figure they can be just as tough as any mule if any balkiness shows up.

Up goes the heaviest part of a 75mm. howitzer to mule's back

Carried by six animals, the gun is set up, ready to be fired

Camera Plane Takes 790 Square Miles in One Shot

TO SPEED the work of photographing strategic stretches of America's coastline, Coast Guardsmen have prepared a twin-engine Consolidated PBY-5 plane, similar to the Navy's long-range patrol bombers, to carry a 750-pound, nine-lens camera developed by the United States Coast and Geodetic Survey. The camera can photograph 790 square miles in a single exposure when flying at an altitude of 34,000 feet.

Glass Cloth for Airplane Covering Passes Flight Tests

Cut like other fabrics, many thicknesses at a time, the glass cloth is easy to shape from patterns . . .

. . . and is sewed onto wings and fuselages by workmen using spun-glass thread and long steel needles

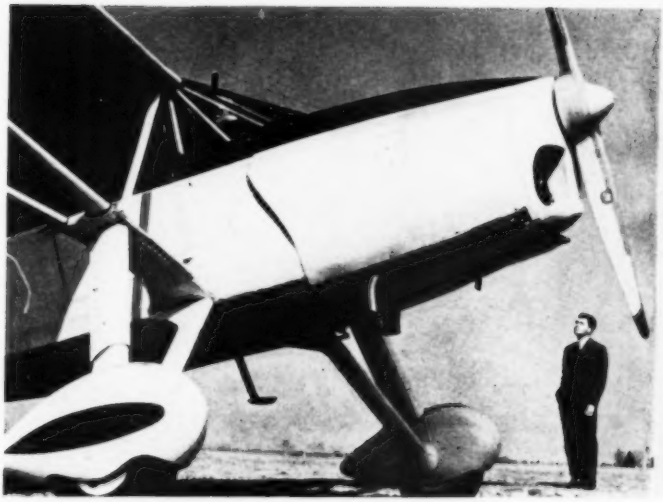
FLAMEPROOF, rotproof, and weather-resistant coverings for airplane wings and fuselages may soon be made of glass cloth, replacing the linen and cotton that have been used since the Wright brothers made their first flights at Kitty Hawk. Wings covered with Fiberglas, a fabric woven of glass fibers, have been tested in flight and proved successful. It is claimed that the fabric is lighter and stronger and absorbs less moisture than the cotton customarily used in light-plane construction, and is unaffected by the sun or temperature changes. When treated with an incombustible "dope," the flame of a blowtorch only scorches it.

The material, itself fireproof, is treated with incombustible dope. Proof of the pudding is shown here

A king crab from Alaskan waters. Uncle Sam believes American fishermen can gather them in economically

U.S. Tries Alaskan Crabbing To Prove It Economical

TO PROVE that the Japanese are not the only fishermen who can catch crabs, the Fisheries Division of the U. S. Fish and Wildlife Service last summer dispatched an expedition to Alaskan waters. The United States imports annually almost $4,000,000 worth of canned crab meat, much of it king crab caught near Alaska. American fishermen who have tried crabbing there in previous years have failed to make a profit because they did not know the hows and wheres of catching and canning the crabs. The fish and wildlife authorities hope that their venture will encourage Pacific Coast commercial fishermen to go after the king crabs, which grow so big that one claw makes several canfuls.



Getting a Job in Aviation

Young America looks to the skies for new opportunities in the world of the future

EXPANSION of the American aviation industry and air forces, civil and military, is creating thousands of opportunities for American youth. What these opportunities are, what training and education are required to take advantage of them, and what they offer is discussed in "How to Get a Job in Aviation." This 96-page publication (sponsored by Air Youth of America, 25c) contains a geographical directory of where to go for training or a job. It lists reference books on aviation, requirements for pilots' and aircraft mechanics' licenses, and office and mechanical jobs in the industry.

Principal contributors are Charles S. Mattoon, personnel director of the Curtiss Aeroplane Division, Curtiss Wright Corporation; Juan T. Trippe, president of Pan-American Airways, and Dr. Robert W. Hambrook of the U. S. Office of Education.

The Farmer's Place in the World Today

THE TRIALS and tribulations of American farmers from the days of the Pilgrim Fathers to the present have been many. What has been and is being done to help them, by science, industry, and government, what progress the farmers have made, and what new problems they face is the subject of "Farmers in a Changing World," the 1,215-page 1940 yearbook of the U.S. Department of Agriculture. (Superintendent of Documents, Washington, D. C., $1.50.)

Handbook for Users of Midget Motors

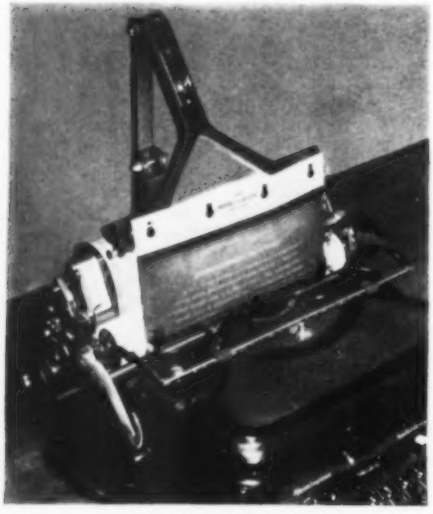
MIDGET MOTORS are being turned out by the thousands to power miniature cars, planes, and boats. To answer the questions of the model maker about these tiny power plants, Raymond F. Yates has written a 241-page book on "Model Gasoline Engines." (D. Appleton-Century, $2.50.)

If your bookseller cannot supply the book you want, order from Book Department, POPULAR SCIENCE MONTHLY, *353 Fourth Avenue, New York.*

Air-Raid Suits Are Made of Fireproof Cloth

NEW YORK style experts are turning from spring fashions to air-raid clothes. The latest creations, shown at the right in light brown and blue, have pointed hoods to protect the face and are made of fireproofed cloth. For protection against shrapnel fragments, plates of one-quarter-inch thick plastic can be slipped into pockets in the lining to cover the chest, back, and midsection. The plastic plates weigh about fifteen pounds as compared to fifty pounds for an equivalent protection of metal. The suits are loose-fitting and designed for warmth.

Worn down, the pointed hood protects the face from heat and flames



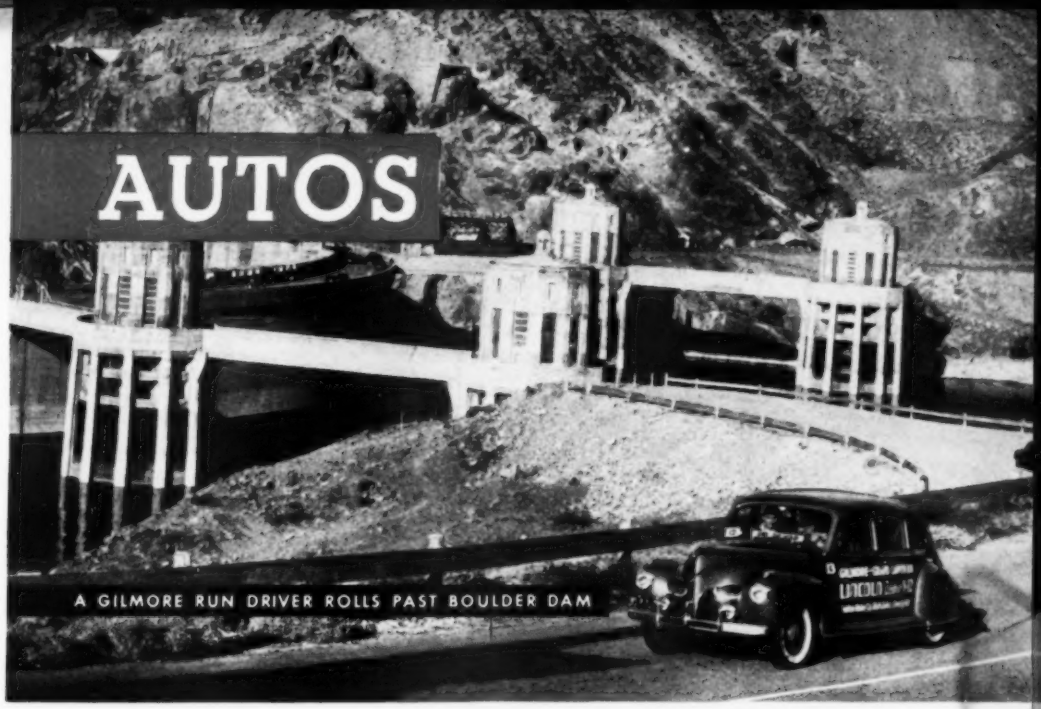
Letters are easily visible when lighted from below

Illuminated Typewriter Roll Speeds Stencil Cutting

AN ILLUMINATED typewriter roll recently placed on the market simplifies the problem of cutting mimeograph stencils. Made of transparent plastic and lighted by a six-watt fluorescent tube mounted in a special fixture, the new roller illuminates the stencil from beneath so that each letter becomes easily visible as it is cut. According to the manufacturer, the roller will last for the life of the machine, maintaining its original smooth surface indefinitely since the type cannot indent the plastic—a fact that also makes it possible to type large numbers of regular carbon copies.

QUICK-FREEZING may soon be employed by commercial bakeries. Frozen batter has been stored successfully for four months.

AUTOS



A GILMORE RUN DRIVER ROLLS PAST BOULDER DAM

TRICKS YOU CAN LEARN FROM THE WORLD'S STINGIEST DRIVERS

(next page)

THE END OF THE ROAD: THE WINNERS AT GRAND CANYON

The Drivers in This Year's Gilmore Economy Run Tell How to Get More Miles from a Gallon of Gasoline

Earl B. Gilmore, sponsor of the Economy Run, with the champ, Marshall Martin, and the trophy of his skill as a fuel nurser

A. C. Pillsbury, in charge of technical details for the AAA Contest Board, waves a Hudson over the finish line at Grand Canyon

By
ANDREW R. BOONE

LET'S take a few tips from the nation's stingiest drivers. We can get far more mileage and greater economy from our automobiles by following their advice. We'll sacrifice no pleasure from our motoring, and there'll be a dividend of unspent dollars at the end of the year.

The 1941 crop of ten extra-special stingy drivers demonstrated their Scotch characteristics recently in the annual Gilmore Grand Canyon Run by piloting cars in ten price divisions 599.3 miles from Los Angeles to the Grand Canyon with an average mileage of 23.368 per gallon. These included sedans weighing, loaded with baggage and passengers, nearly three tons. And most of the run was uphill!

Performance was determined by multiplying the weight of the car in tons by the number of miles driven and dividing the result by the number of gallons of gas consumed. A competitor rode with each driver as observer. The man at the wheel kept his motor running and in gear, indulged in no downhill coasting, kept his foot off the clutch pedal, and obeyed all traffic regulations—or else.

Stingiest of all is Marshall Martin. This young man demonstrates Fords, Mercurys, and Lincolns at the Long Beach plant of the Ford Motor Company, and chauffeurs Edsel Ford around Southern California when the motor magnate visits in the West. Martin's good, and knows the answers. He won

the sweepstakes prize by driving a Lincoln custom 5,500-pound car over the route at an average of 57.827 miles per ton, or 21.03 miles per gallon for the car. (That weight includes 850 pounds of passengers and baggage.)

Remember that ton-mileage figure, for it's really the way to calculate what you're getting from the power pouring into the cylinders. You can't expect to coax the same results from a super-deluxe $4,000 three-ton sedan as from a $1\frac{1}{2}$-ton jallopy. How did Marshall achieve such an impressive victory? Except for the advantage of having unusually skilled technicians to get the car ready, he had no more help than you can get at the corner garage. Of course, you'll have to match your driving skill against his.

In common with all the 23 sedans entering the run, Marshall's car first had its engine tuned. The carburetor was adjusted to the first step lean, with the fuel level at the low limit to get an air-gasoline ratio of 14.8 to meet the requirements of high-altitude driving. Most of the run was around the mile-high level. Valves were ground, and parts fitted to standard tolerances. Engine heat was set at 190 degrees by thermostatic control. "This," confided Marshall, "is an ideal operating temperature, but most cars are set for 160 degrees, owing to the probability of alcohol antifreeze solutions boiling off in cold weather."

Carefully, Marshall and his boss, Jack Young, calculated two running schedules—one for good weather, the other for bad. Twice Marshall drove over the route to familiarize himself with road conditions. Several days before the run started, he delivered the car into the hands of American Automobile Association officials. They went over the sedan from bumper to tail lights, making sure it was entirely stock. They removed all lubricants, stripping the car down clean. Mechanics lubricated it anew, and poured S.A.E. 10 motor oil down the breather pipe. They weighed the vehicle, weighed Marshall and his observer and their baggage, and, after topping off the gas tank, sealed everything movable, from carburetor to clutch adjustment.

Through cities all the operators drove no faster than 35 miles an hour. In open country, they set a steady pace of 58-60 miles an hour from their starting point, 300 feet above sea level, up a series of twisting

Pouring a measured amount of oil into a Packard cylinder head to make sure it is a stock part. All entries got this test

ECONOMY TIPS: YOUR CAR

1. Make sure all brakes are free.
2. Have the carburetor mixture as lean as will provide smooth operation of a warm engine.
3. Timing should be exact.
4. Check the electrical system regularly, for loss of current causes poor ignition.
5. Inflate tires to pressure recommended by manufacturer.
6. Never use a lubricating oil heavier than condition of engine warrants.
7. Flush radiator twice yearly with clean water.
8. Have the engine tuned up every 60 days.

. . . AND HOW TO DRIVE IT

1. Drive at a moderate speed.
2. Keep a steady pace.
3. Don't gun your engine when starting.
4. Kill the engine when stopped for one minute or longer.
5. Don't choke the carburetor longer than 60 seconds, even on cold mornings.
6. Roll up to boulevard stops in gear, saving brakes.
7. Depress foot throttle only far enough to maintain desired speed.
8. Let the other fellow get away first.

Testing synchronization of breaker points on a Packard 120, which won in its class with 19.78 miles per gallon

Grease was stripped from all bearings on contestants' cars and replaced with the factory-specified lubricants

Here a Ford V-8, winner in its class with 23.05 miles a gallon, is being lubricated with standard products

mountain climbs, to Grand Canyon, 7,000 feet above.

Second and third in the sweepstakes were Horace M. Jones in a Lincoln Zephyr, and William C. Martin in a Studebaker Commander. Like Marshall Martin, they drove with a steady throttle, No. 1 requirement for economical operation of any motor car.

Jones "scotched" his Zephyr up the long pull with 57.827 miles a ton, or 22.96 actual miles per gallon.

"The average driver," he emphasized, "wastes considerable gasoline because he doesn't take time to do a few simple things. How often does he shut off the engine while talking 10 minutes to a friend? He burns enough fuel to drive two miles. How many accelerate wide open and jam on the brakes at the next stop? They could get along on one third the fuel by taking it easy. How many jam the throttle down on a hill? They'd get another five miles an hour in second."

Statistics offer dry reading usually, but Bill Martin, who coaxed 24.36 miles from every gallon, pointed out a few comparisons of great significance. According to a study made by the Automotive News, an engine in good condition will consume a half quart of oil in a 1,000-mile drive at 25 miles an hour. At 65, it uses 4½ quarts. Between these two speeds, your gas bill will jump from $8.75 to $14, your tire cost will zoom from $1.50 to $10.50, maintenance leaps from $4 to $13, and your overall cost per mile leaps from 1.444 cents to 3.86 cents.

All these experts declare 55 miles an hour to be an economical road speed, provided you maintain a steady throttle. On that 1,000-mile jaunt to see the folks, you get a little anxious after the first hour or so and push her up to 65. You'll save exactly 2.8 hours, but that extra ten miles an hour will cost you an extra $8.30. It's simply a question of whether vacation time is worth $2.96 an hour.

Common sense in preparation and driving gave these men high mileage. Each emphasized a particular point when I asked how motorists can improve both performance and economy.

J. C. Marbre, Willys Plainsman, 29.06 miles per gallon: "Remember, air is free, and gasoline isn't. So in adjusting the carburetor, have the mixture as lean as will provide smooth operation of a warm engine. As for the ignition system, make sure timing

is exact, distributor points are in good condition, spark plugs sound and clean, wiring insulation intact and connections firm, battery full-powered, battery cables leakproof and terminals connected tightly. Surprising, how loss of current in transmission from battery causes poor ignition and waste of power."

William Knopp, Ford V-8, 23.05 miles per gallon: "Check all tires to make sure they are inflated to the pressure recommended by the manufacturer. Soft tires cause greater road friction. Also, they wear out more quickly."

To which Andy Henderson (Nash 600, 25.81 miles per gallon), added: "By the same token, don't overinflate tires. This reduces traction and often causes the wheels to spin needlessly when you step on the throttle. The narrowed tread wears more rapidly, too. Make sure the wheels are in alignment."

Glenn White, Hudson 6 De Luxe: "Don't use a lubricant heavier than the condition of your engine warrants. Modern motor oils and lubricants enable us to use lighter weights than formerly, thus diminishing the drag on moving parts. Whenever you step up to a heavier oil or grease, that drag increases."

H. N. Kyser, Studebaker President, 22.53 miles per gallon: "An overheated engine causes metals to expand unequally, pinching moving parts and eventually 'freezing.' So long as the water circulates freely, there will be little danger from this source. So flush the radiator twice a year with clean water—and make sure the pump is packed and lubricated, and the fan running properly."

Lee Winchester, Chrysler Windsor, 20.14 miles per gallon: "Maybe you'd like to choke another driver for beating you to the intersection, but don't choke your carburetor to excess. Most cars have automatic chokes, but if there's a choke knob on the dash, shove it in as soon as you drive two blocks. A rich mixture represents so much waste with a warm engine."

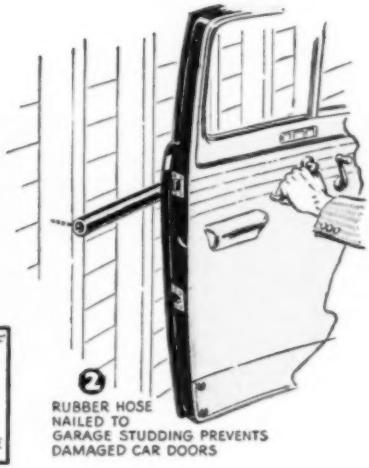
L. P. Butts, Packard 120, 19.78 miles per gallon: "Accelerating to speeds from which you brake at frequent intervals wastes fuel and wears the brake linings. That flashy departure, leaving traffic behind, may be spectacular and satisfying, but it costs three times more than an easy step-up through gears."

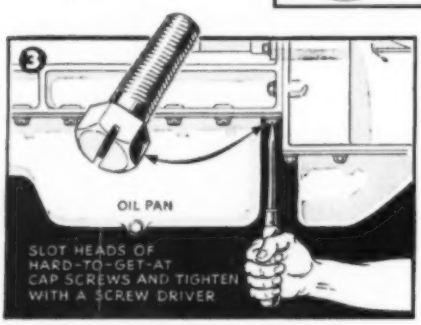
Each car carried four chains, which were fitted carefully

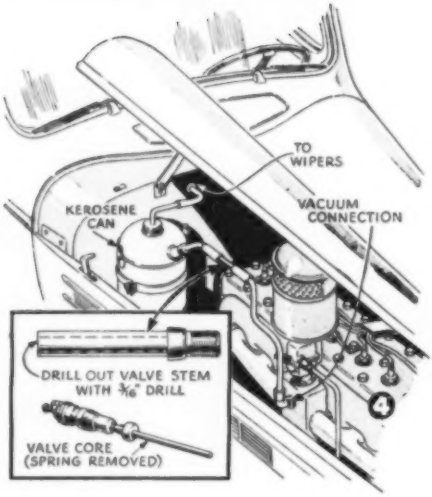
Passengers and baggage were weighed in before the run

An official seals the gas tank of an entry at the start

EIGHT HANDY IDEAS







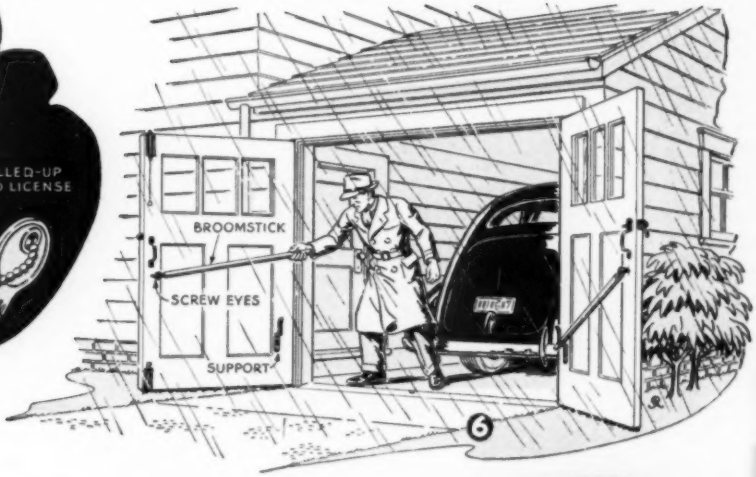
1 DIMMING THE DASH LIGHT often makes it possible to see more clearly when driving at night, particularly in fog or rain. With a rheostat-type heater switch installed between the dash lamp and the main light switch as shown, the driver can control the amount of light on the dashboard, or turn the light off completely if driving conditions make it desirable.—A. Z.

2 CHIPPED PAINT or possibly a bent handle on the door of the car can be prevented by nailing a piece of old garden hose to the inside of the garage wall. Drive the nails only through the part of the hose next to the wall so the nail heads will be covered and the door cannot hit them.

3 HARD-TO-GET-AT cap screws, in places such as the narrow space between the oil pan and the flywheel housing, can be replaced without the aid of special wrenches if the heads are slotted with a file or hack saw so that a screw driver can be used to turn them.—M. R.

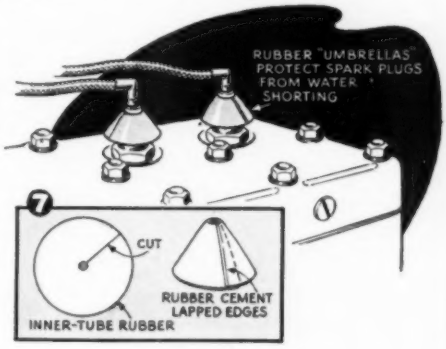
4 A BOOSTER for vacuum-operated windshield wipers, made from a two-quart or gallon kerosene can and a tire valve stem and core, will keep the wipers working for a good many strokes after the accelerator is pressed to the floor. The spring should be removed from the valve core and the rubber scraped from the valve stem and seat. If the rubber is not removed, gasoline may cause it to swell and clog the valve.—H. W. R.

FOR THE MOTORIST

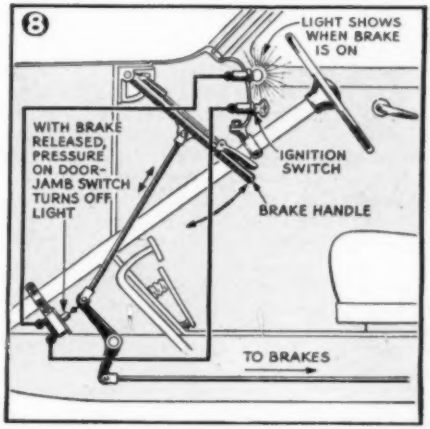


5 CAR LICENSE AND KEYS can be kept together neatly with an old fountain pen and a key chain from the five-and-dime store. Remove the point and sac from the barrel of the pen and drill a hole through the end for the key chain. The clip on the pen cap will keep it in your pocket.—W. L.

6 STEPPING OUT IN THE RAIN just to close the garage doors is always an unpleasant way to end a journey. By attaching old broom handles or similar poles to the doors with screw eyes as shown, however, you can pull the doors shut from inside the garage. The poles can also be used to prop the doors open.—A. E. O.



7 RUBBER UMBRELLAS for your spark plugs will usually keep splashed water or a driving rain from shorting the plugs and leaving you stranded. Cut disks from an old inner tube and slit them from the center to the edge. Lap the edges and fasten them with rubber cement, as illustrated in the drawing. Place them under the screw cap of the plug.—L. O. D.



8 A WARNING LIGHT hooked up as shown in the diagram will enable a driver to tell at a glance whether the emergency brake is fully released and will reduce the danger of driving with the brakes partly applied and causing unnecessary wear. Wiring the circuit through the ignition switch will cause the light to go out when the engine is turned off.—F. M.

Gus reached up, jabbed an index finger into a damp spot under the footboard, and sniffed the finger. "Oil," he said. "What's the gag, Tim?"

GUS learns something new

By MARTIN BUNN

A HORN honked raucously outside the open shop door of the Model Garage. As Gus Wilson looked up from the carburetor adjustment on which he had been intent, a coupe, vintage of 1935, which he had never seen before, was driven in. From it emerged a cheerful-looking pooch of obviously scrambled ancestry, which ran over to him with shrill yaps of greeting, followed by a tall and lean young man whose thin-cheeked face was topped by a shock of touseled yellow hair and decorated by a pair of rubber-tired spectacles. "Hello, Gus," the young man said. "Long time no see."

There's no one that Gus Wilson thinks more of than Tim Sheridan, who, he contends, has more than a touch of mechanical genius in his mental make-up. But Gus isn't at all the sort of guy who gets sloppy about it when he likes you. He leaned over and patted the dog's shaggy head. Then he looked at Tim. "What are Dodger and you doing here?" he wanted to know. "Lose your job?

"Who, me?" There was disdain in Tim's voice. "No, *sir!* Why, they couldn't run that airplane-engine plant up there in Hartford without me! I'm just home over the week-end."

Gus grunted and tossed a deprecatory glance at the six-year-old coupe. "What's

that old thing you're driving?" he asked.

Tim grinned widely. "Picked it up cheap in Hartford," he said. "I had to have something with wheels on it to get back and forth between the boarding house and the job. That car's a real wonder, Gus. I never saw a bus that had so many queer things the matter with it."

Now Gus looked really interested. "Such as what?" he inquired.

Tim draped his lanky six feet over the end of the workbench, pulled tobacco sack and papers from his pocket, and expertly rolled himself a cigarette. "Such as this," he said when he had lighted it. "It uses up an awful lot of oil. And what happens to the oil? Why, it goes into the transmission."

"Now I know you're screwy," Gus said. "There's no way in which engine oil can get into that car's transmission."

"I know there isn't," Tim admitted. "But that's what it does."

Gus grunted, but offered no further protest. Then he called to his helper to put the car on the lift. When it was raised, Gus and Tim walked underneath and gazed up at the greasy-looking bottom of the car.

"What's this hole in the bottom of the flywheel housing?" Gus asked after a little.

"The used-car dealer I bought this jallopy from put that hole there," Tim explained, "to carry off the oil. But, as a matter of fact, very little comes out there."

Gus reached up, jabbed an exploratory index finger into a damp spot under the footboard, and then sniffed the finger. "Oil," he said. "Come on now, Tim—what's the gag?"

"No gag at all," Tim told him. "I put engine oil in at the filler pipe, and after I've driven for a while most of it is in the transmission. I know that's impossible, but I'll prove to you that it's a fact. You can take my word for it that just before I started this morning I drained all the engine oil out of the transmission, and filled up with fresh transmission lubricant. Now watch."

He placed an empty tin can under his car, and opened the plug hole at the bottom of the transmission.

Oil poured smoothly into the can. Gus poked a finger into it, and again sniffed the finger. "It's mostly engine oil, all right," he admitted.

"You're darn tootin' it's engine oil," Tim said. "How the dickens it gets there is what burns me up!"

"We'll find out," Gus said. "Let me at it!"

He got at it.

An hour later he still was at it. Checking, rechecking, and triple-checking had thrown no light on the mystery of the strange behavior of the oil.

Gus straightened up, pushed his long-peaked mechanic's cap back from his furrowed forehead, and swore under his breath. Tim squatted back on his heels, absently rolled himself another cigarette, and forgot to light it. "Well," he said after a silent minute, "it looks as though we're licked."

"Licked nothing!" Gus snapped. "We're just stopped temporarily. And I've found that when you're stopped on a trouble-shooting job it's often a good idea to work on something else for awhile, and then go back to the original grief. What are some of the other things that are the matter with this collection of junk?"

Tim's wide grin lit up his thin face. "To mention just a couple of them," he said, "there's a knock that sounds to me like a bum main bearing, and there's something very screwy about the fuel pump. I haven't had a chance to do any real checking—I've been working overtime almost every day, and studying airplane engines half of most nights."

"I'm glad to hear it," Gus said unsympathetically. "Plenty of good hard work is what you kids need most. . . . Let's have a look at those main bearings."

They took off the oil pan, and then the rear main bearing cap. "It doesn't look so bad," Gus decided, "but we'd better check—"

He stopped and stood looking at the bearing.

"Lost your voice?" Tim inquired. "Or do you—"

"Look at that," Gus said, pointing. "See what I mean?"

Tim peered intently. "All I can see," he said, "is that sometime some one shimmed up that bearing. What of it?"

"What of it?" Gus repeated scornfully.

His eyes had caught the glitter of a sliver of metal on the end of the pump arm. "There's your trouble!"

"Nothing of it—except that right there, staring you in the face, is the solution of the mystery of how your engine oil gets into your transmission. Use your eyes, Tim—and what's back of 'em!"

Tim did a couple of minutes of hard thinking. Then he shook his head. "Nope," he said, "I don't get it."

Gus laughed. "I didn't get it myself at first," he admitted. "When whoever it was that shimmed up that bearing fitted the bearing cap back on, he carelessly covered up the return drain hole. That forced the engine oil to run into the flywheel housing. Then—"

"Wait a minute! Wait a minute!" Tim said. "The used-car dealer cut that hole in the bottom of the flywheel housing so that the oil could run out of it."

"Sure he did," Gus concurred. "But you said yourself that very little oil ever ran out of it. And why not? Because the flywheel threw the oil against the slope of the bell housing. From there it ran down to the forward transmission-shaft bearing and through it into the transmission. After you've put in a new main bearing your engine oil will stay where it belongs."

"By jingo, you've hit it right on the nose!" Tim cried admiringly. "Did you ever run into a thing like that before, Gus?"

"No, it's a new one on me," Gus admitted. "I don't suppose that a thing like that would happen once in a million times. Well, that's one of the good things about this job, Tim—you keep on learning things. Now how about that fuel pump? We might as well get this bus of yours fixed up so that it will get you back to Hartford."

"Well," Tim said, "I think that it is the fuel pump, but I'm not dead certain of it. As I told you, I haven't had time to do any real checking since I bought this car. It ran pretty good—considering—for a few days. Then one morning, while I was on my way to work, the engine coughed a couple of times, sputtered for a few seconds, and then went dead. I made a quick check of the gas line, and found that it was O.K. But the engine wouldn't start. While I was fooling with it one of the boys in my shop came along and gave me a push. The engine started right off then, and the car ran all right the rest of the way to the plant.

"When I came off shift that afternoon I thought I'd have a battle getting going, but I didn't. The engine took off as soon as I stepped on the starter.

"After that the car ran all right for a couple of weeks. Then the same thing happened again. That night I took enough time out to check the gas line, the battery, the wiring, the distributor, and the plugs—all O.K. I didn't have time to take the fuel pump apart and check it. But everything else seemed all right, so I figure that it must be the fuel pump that has gone bad."

"How about your windshield wiper?" Gus asked. "The way it acts often is a good check on the way the fuel pump is working. If the wiper is slow in action when you step on the gas, there's a good chance that the vacuum pump coupled to the fuel pump isn't doing its job right, or even that it isn't working at all—and just about as good a chance that it has a broken diaphragm. If there is high gasoline pressure and a lot of noise, it probably means that the rocker-arm pin and link of the vacuum pump are shot."

"I don't remember that there was anything wrong with the wiper the last time I used it," Tim said. "But I'm pretty certain that the trouble is in the pump—I don't see where else it could be. I've got to get busy and fix it, too. She went dead on me three times coming down from Hartford."

"Let's get the pump off and have a good look at it," Gus said.

He removed the fuel pump from the car and took it apart. The diaphragm wasn't cracked and all the other parts were in good working order, so he cleaned them thoroughly and put the pump together again.

"Well, that wasn't it—so what *was* it?" Tim asked as Gus prepared to replace the pump on the car.

"Dunno," Gus said. "Hello!" His keen eyes had caught the glitter of a bright sliver of metal on the end of the pump arm, where it works against the cam. "Hold on there a minute, Tim—there's your pump trouble!"

"Huh?" asked Tim. "What do you mean?"

Gus was examining the pump arm. "Yep, that's it," he said. "This arm is sprung a little, and sometimes instead of engaging the cam it slips to one side of it. That's the how-come of that sliver of metal that tipped me off. It was shaved off when the arm almost *(Continued on page 218)*

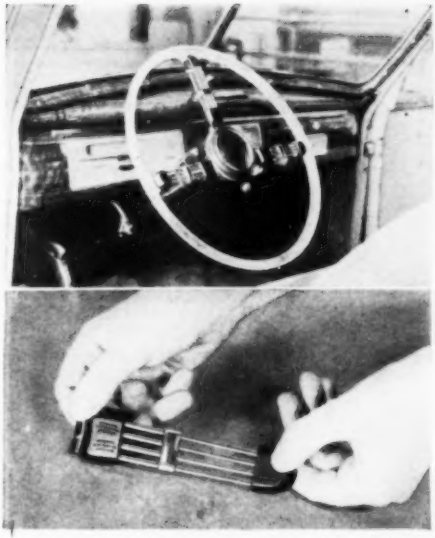
GUS SAYS:

Back in the old days, you learned that it was good manners to dim your headlights when you met another car on the road. It's even more important with the new sealed-beam lights. Watch that pilot light on your dash and see that it's out when you sight an oncoming car!

Auto Ideas

Ornamental Rib-Type Spokes Dress Up Old Steering Wheel

STEERING wheels with solid spokes can be modernized with the auxiliary chrome-plated ribbed spokes shown in the illustrations at the right. Available in attractively boxed sets of three at a moderate cost, they come equipped with all necessary hardware for attaching them over the existing steering-wheel spokes. Adjustable in length to wheels of any radius, the accessories take only a few minutes to install, a screw driver being the only tool required for the job.



A screw driver is the only tool needed to install the adjustable spokes on the old steering-wheel spokes

Magnetic Gauge Measures Thickness of Car Enamel

ENAMEL thickness—an important criterion of its durability—is measured quickly and accurately on Ford cars by means of a magnetic tester that registers the thickness on a dial when a tiny detector is touched to either a flat or rounded enameled-metal surface. Thus cars with insufficient enamel to stand up for the expected life of the vehicles are instantly spotted for return to the finishing department.

Emergency Car Battery Has Power To Spare

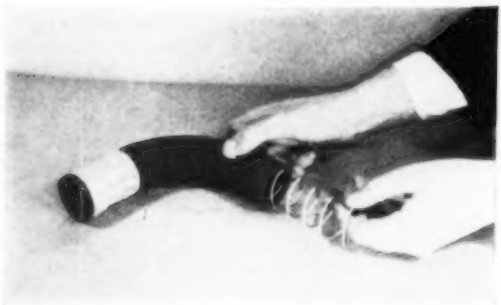
AN EMERGENCY starter battery for garages and service stations engaging in road service has just been announced. Provided with a rubber-composition case to withstand rough usage, the battery has four cells supplying eight volts instead of three cells supplying the usual six. Extra-long, heavy cables make it unnecessary to install the battery in a car to get it started, and the extra voltage assures quick action.

Extension cables attach easily to the stalled car's terminals

Auto Ideas

Special Tool Kit Helps in Embarrassing Moments

MOTORISTS who like to be prepared for emergencies such as may result from unexpected encounters with mud, snow, or mechanical troubles, will appreciate a kit of tools to aid in extricating the car from unpleasant situations. It contains cotton working gloves, a towing cable, a combination ax and shovel, two auto rafts or tracks on which to run the rear wheels out of a mud hole, twelve-minute flares, and a folding canvas bucket with a spout, for filling radiators.



Coiled Wire Inside Hose Saves Radiator Trouble

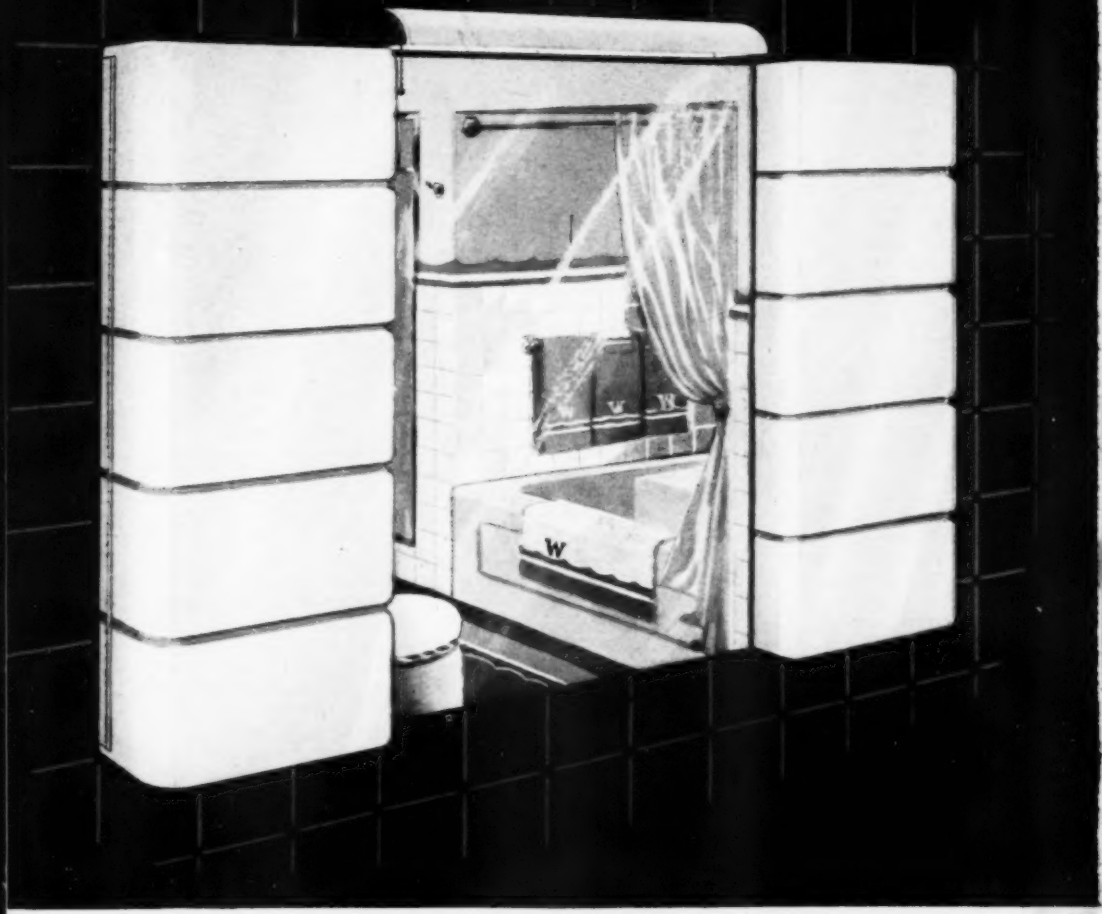
CURVED radiator hoses which are not sufficiently reënforced, combined with the powerful water pumps on many modern cars, occasionally collapse and interfere with proper circulation of the cooling water. To overcome this difficulty, coiled wires in sizes to fit inside the hoses and prevent collapse are now available at service stations and garages.

Extra Car Goes Inside Trailer on Family Trip

NOT SATISFIED with one car in the family when they are traveling, Mr. and Mrs. J. H. Van Blois, of Fenville, Mich., made room in the dining section of their trailer for a "junior" car. When they stop for a few days along the road, portable runways are adjusted, and they have a car to use on shopping and sightseeing trips without unhitching the trailer from the car which tows it.

J. H. Van Blois, ready for a spin, backs car out of trailer dining room

HOME *and* WORKSHOP



Prize-Winning Medicine Cabinet

AS MODERN AS TOMORROW, THIS DESIGN TOOK FIRST HONORS IN OUR CONTEST. COMPLETE PLANS ON A FOLLOWING PAGE

Medicine Cabinet Contest Winners

FIRST PRIZE, $50

S. C. Carpenter, Cleveland, Ohio

SECOND PRIZE, $25

Arthur L. Finn, Mount Vernon, N.Y.

THIRD PRIZE, $15

John W. Knobel, Ozone Park, N.Y.

FOURTH PRIZE, $10

Marvin J. Neivert, Lawrence, N.Y.

FIFTH PRIZE, $5

Don Fosler, Seward, Nebr.

HONORABLE MENTION

Ralph E. Bisel, Badin, N.C.; Joseph Ceneska, Cohoes, N.Y.; Morris Cohn, Bronx, N.Y.; Willis Cronau, Kewanee, Ill.; Henry Date, Alameda, Calif.; Harry G. Froese, Minneapolis, Minn.; Robert A. Glacy, Richmond Hill, N.Y.; James M. Hart, Detroit, Mich.; L. Percival Hutton, Winter Park, Fla.; Clyde Johnson, Pittsburg, Calif.; A. A. Lipsey, Chicago, Ill.; Michael S. Mathes, Houston, Tex.; Alfred Newbauer, Irvington, N.J.; Thomas O'Brien, Butte, Mont.; H. W. Richter, Kalamazoo, Mich.; Erwin F. Schreiber, New York, N. Y.; Thomas Stopa, Waupun, Wisc.; E. F. Sullivan, Rawlins, Wyo.; A. A. Thogersen, Santa Monica, Calif.; Albert Werner, Hollis, N.Y.; Norman Werner, Jr., Pottstown, Pa.; Howell P. Williams, Clairton, Pa.

THE ideal bathroom medicine cabinet should have a mirror on the inside as well as on the outside. This was the opinion of the majority of readers who entered our contest for better medicine-cabinet designs (see P.S.M., Nov. '40, p. 163). They stressed the importance of having ready access to the shelves, or at least to some of them, while using the mirror. In this respect they seemed to think the ordinary commercial cabinet was deficient and, in fact, not as good as the so-called "hotel type" cabinet, which has an open shelf under the mirror.

Other desirable features, as indicated by the hundreds of entries, are: more shelf space, fluorescent lighting, electric outlet, locked compartment for dangerous drugs, and racks for toothbrushes, scissors, and tweezers. Cleansing tissues have become so indispensable to the modern household that many contestants thought there should be a special compartment or dispenser for them.

First prize was won by a design that is purely functional, yet styled with the most discriminating taste. It is a built-in cabinet in three units. The spacious center unit has a mirror, which is hung on the door with mirror clips. Three shelves behind the door are used for storing medicines and medical supplies, and there is a locked compartment for poisonous drugs and chemicals at the top.

Flanking the center unit are side cabinets —one for "him" and the other for "her," so as to eliminate all arguments about who uses more space. There are three shelves inside each unit, large enough to hold all necessary toilet articles. Inside the door of each unit is a mirror. When both doors are open, these mirrors supplement the central mirror to afford side and back views of the user.

There is an electric outlet in each side unit, and a small drawer, that on the man's side being convenient for the disposal of used razor blades, that on the woman's side for holding hairpins, bobby pins, curlers, and the like. Both units have toothbrush racks.

An innovation of marked utility is a single shelf that projects from the door of each side unit when the door is open. On this shelf the toilet articles in use can be laid down temporarily within easy reach.

Indirect lighting is desirable for use with this cabinet, and the designer suggests that it can best be accomplished by installing a single fluorescent tube directly over the center mirror.

Second prize was awarded for a simple but efficient design which includes adjustable fluorescent-tube lights, a special compartment for sterile first-aid dressings, a shelf with a ledge to prevent small articles from rolling off, and an open shelf, with an electric outlet, at the bottom.

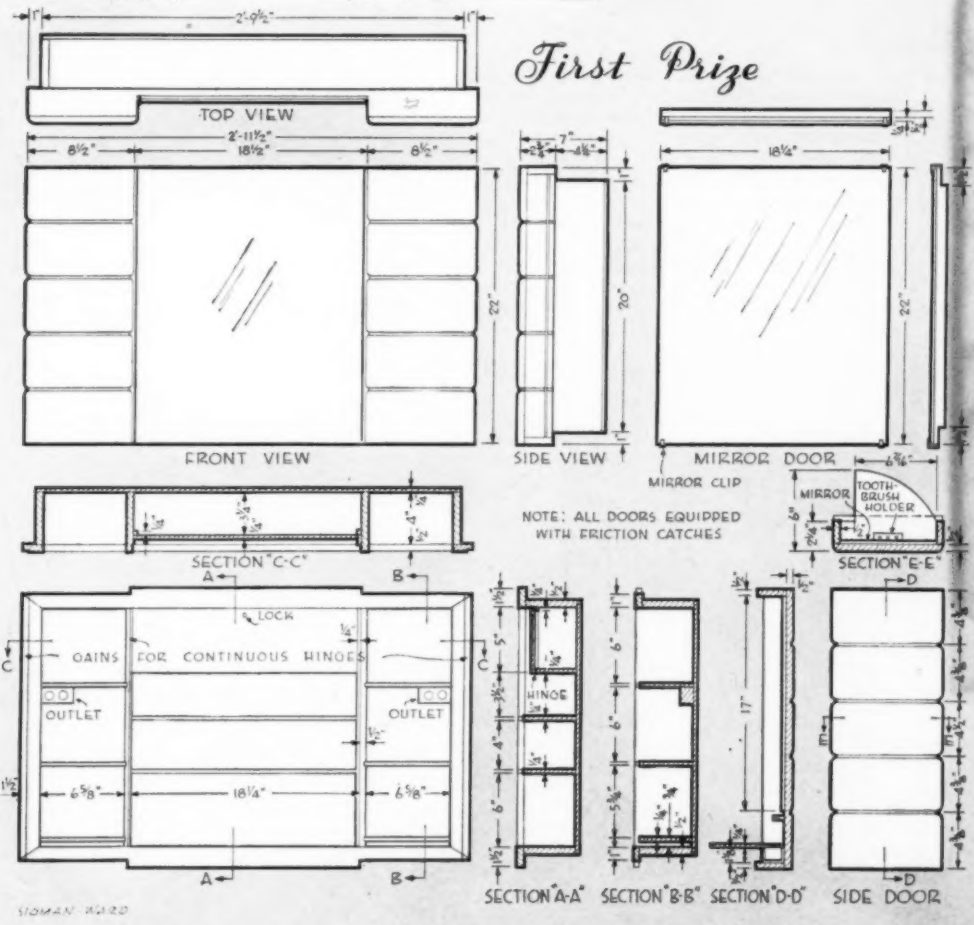
Shelves designed to hold bottles, jars, and tubes of varying sizes and shapes distinguish the third prize-winning cabinet. Side cabinets eliminate the annoyance of opening a

MATERIALS

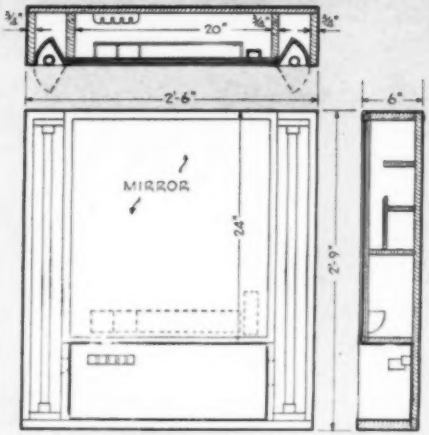
1	Mirror door,	¾x18¼x22
2	Side-door fronts,	½x 8½x22
4	Side-door sides,	½x 1¾x21
4	Side-door tops and bottoms,	½x 2¼x 8½
2	Side-door shelves,	¼x 5½x 7½
2	Chest sides,	½x 4 x20
2	Chest top and bottom,	½x 4 x32½
1	Chest back (plywood),	¼x20 x33½
2	Chest partitions,	½x 4½x19
6	Chest side shelves,	¼x 4 x 6⅞
2	Chest shelves,	¼x 4 x18½
1	Bottom for locked cabinet,	¼x 3¼x18½
1	Door for same,	¼x 5 x18¼
1	Door stop for same,	¼x ¼x18
2	Door stops for same,	¼x ¼x 4¾
1	Mirror door stop,	¼x ¼x19
2	Upright casings,	½x 1½x21
2	Top and bottom casings,	½x 1½x35½
1	Center mirror,	18¼x22
2	Side mirrors,	7½x17
2	Toothbrush holders	
2	Metal boxes with small knobs,	1⅛x 1¾x 7½

NOTE: All dimensions are given in inches.

First Prize



SIDNEY RAND

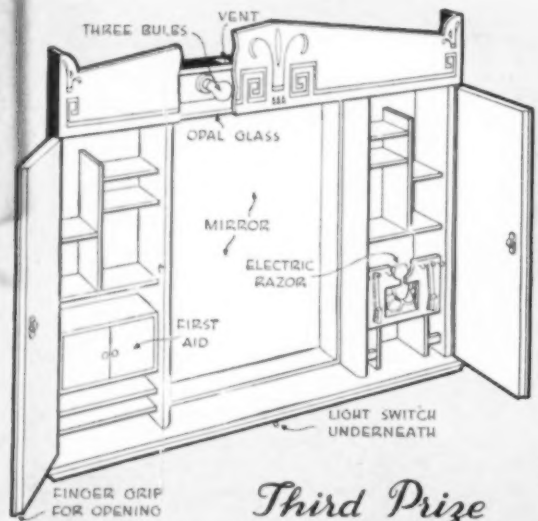


Second Prize

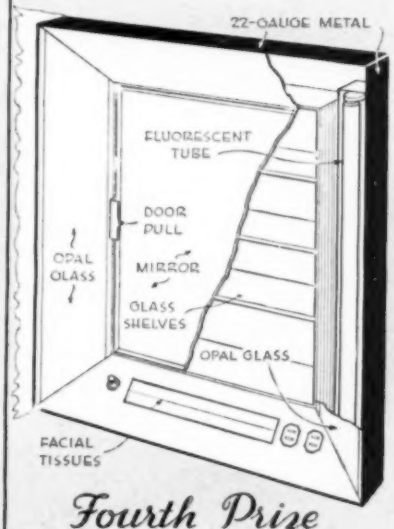
mirror door to obtain the articles inside. Illumination is supplied either by three bulbs above the mirror, their light being diffused by opal glass, or by tubular or fluorescent lamps at the vertical sides of the mirror. Decoration of the cabinet follows a modernized Greek motif. Suggested overall dimensions are 33⅝" high, 38" wide, and 5½" deep.

The frame of the fourth prize-winning cabinet is cut and bent from 22-gauge metal, which is light enough to be easily worked by hand. Fluorescent lights shine through vertical opal-glass windows, and an outlet is provided for electric appliances. Cleansing tissues are stored in a special dispenser from which they can be pulled out through a slot. The cabinet is enameled white or to suit the bathroom color scheme, and the designer suggests it be made 21" high, 19" wide, and 6" deep.

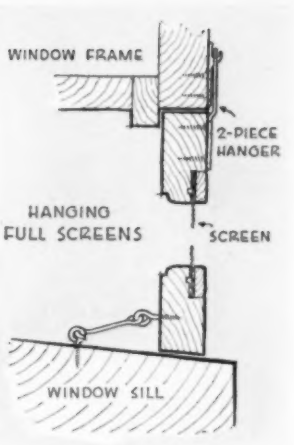
Only four prizes were originally announced, but a fifth prize of five dollars was awarded to a reader who not only designed a cabinet, but built it and submitted photographs as well as drawings. Its outstanding features include a special electric-razor compartment, side cabinets with doors that give additional reflected light when open, adjustable shelves, and a small glass shelf below the mirror. The complete cabinet cost less than ten dollars to make.



Third Prize



Fourth Prize



Full screens are hung from standard fittings at the top. Hooks hold in the lower ends securely. Identify screen as shown below

House Screens

AND HOW TO CARE FOR THEM

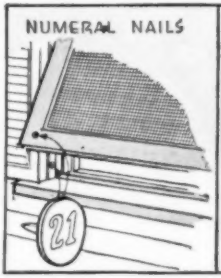
IF HOUSE screens are properly cared for and stored away each fall, hanging them in the spring becomes a pleasant chore.

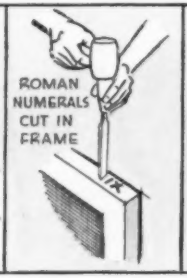
Each screen should be permanently identified with the window on which it belongs. Numbered tacks may be used, or Roman numerals chiseled into the edges of the frames. If compass designations are used, as in the third drawing at the right, it is necessary to mark only the screens.

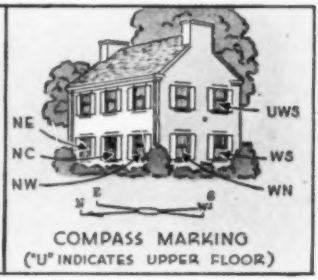
Screens that are in good condition need only be cleaned before storing. Brush both sides of the netting with a whisk broom. If a vacuum cleaner is available, the suction-brush attachment will do the work quickly, with a minimum of dust. Kitchen screens that are subjected to cooking vapors may be brushed with benzine to remove grease deposits. Hardened dirt on the lower rail can be removed with a damp cloth sprinkled with kitchen cleanser.

If the screening is broken, buy a new piece at least an inch wider and longer than the old screening, and paint the wood of the frame beneath the molding if necessary, since rotting will occur at this point if moisture lodges between unpainted wood and molding.

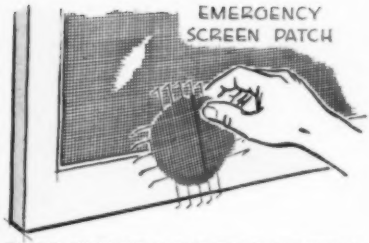
Screening should be applied to the frame





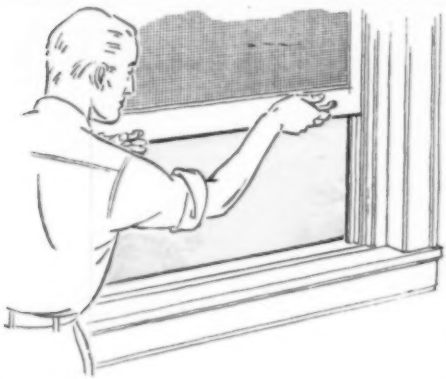


Store screens flat, in a dry place, and cover to keep dust-free



PLACE OVER HOLE AND BEND EXTENDING ENDS OF WIRE THROUGH MESH

Prompt repairs cost little, may save a screen. Use benzine only in well-ventilated places, away from fire



To avoid undue wear on frame joints, raise sliding screens by handles screwed to the lower rails

with tacks 5/16" or ⅜" long, spaced about 2" apart. To insure tautness, tack one end first, then the other, and finally the two sides, beginning at the middle and stretching the wire as you progress toward the ends. Cut off excess wire and replace the molding. If pliers are used to pull screening taut, take care not to draw the mesh out of shape.

A weak frame can be strengthened at the corners by means of dowel pins, corrugated fasteners, or braces. Dowels and fasteners should not be used as reënforcements on mortise-and-tenon joints, since they are likely to split the wood, but they are suitable for butt or mitered joints, provided the original nails or screws do not interfere. As a rule, corner braces, when practical, make the best reënforcements. A sagging screen door that drags on the threshold can be corrected by fitting a turnbuckle brace.

Half screens that raise and lower by sliding inside the window frame should not be forced up by pushing on the top rail as this may pull the joints apart. Screw a pair of handles to the bottom rail. A method of using common window spring bolts to hold trackless half screens is illustrated.

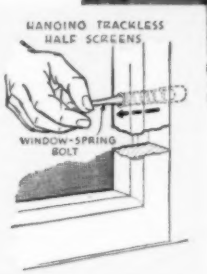
Screen frames, wire, and hardware should be protected from rot, rust, and corrosion. In most climates repainting of wooden and iron parts is advisable about every other year. Black iron screening may need attention every season. There are numerous paints especially made for screening. If ordinary paint is used, it should be thinned considerably with turpentine to avoid clogging the mesh. Instead of a brush, a piece of old carpet tacked, nap outward, to a wood block may be used. Paint will bond better

on new galvanized iron screening if the wire is first washed with vinegar. Bronze and copper screening require no painting.

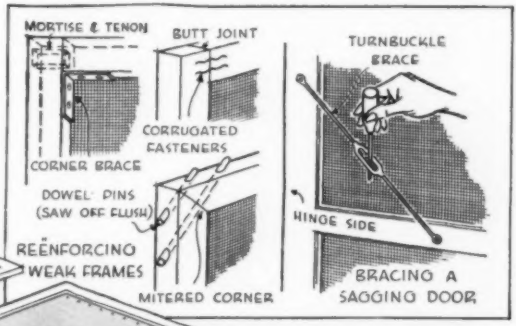
Polished brass and copper hardware may be protected with a coat of clear lacquer. White bronze metal needs no protection. In locations where copper screening oxidizes excessively, causing drip stains on the house paint below the windows, bronze screening should be used.

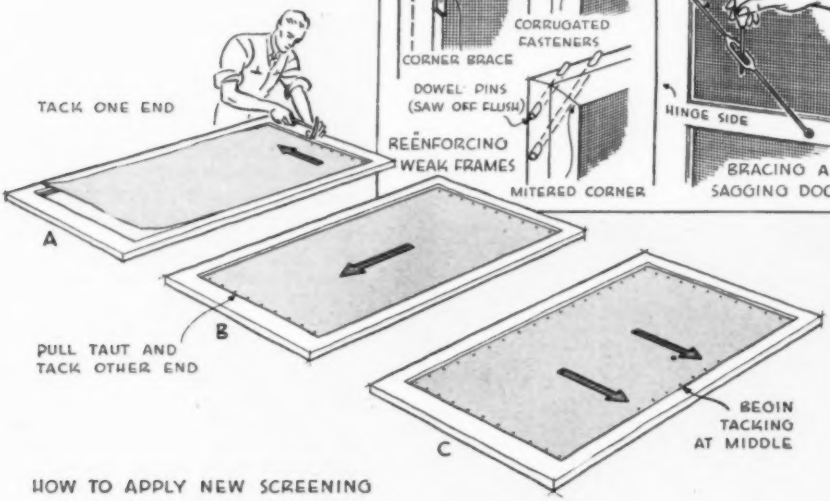
Some home owners, who hang their storm doors immediately upon taking down their screen doors, leave the hinges permanently screwed to the door frame and mount the two doors interchangeably on the same hinges. Removable pin hinges are sometimes used for screen doors. If the hinges are left on the door, it is a good idea to plug the screw holes in the frame with match sticks or composition wood as a matter of routine each season. A daub of paint will then tidy up the hinge blemish and seal the holes against weather.

The proper storage of screens is an important part of their care. Some arrangement, away from floor dampness, which will permit the screens to be laid flat is recommended. A cradle hung from the basement ceiling is excellent, or storage as shown in one of the photographs. Lath or other strips should be laid between the frames if hardware, such as hooks and hangers, would otherwise interfere with stacking them flatly and neatly. Cover the screens with paper or canvas to keep out dust. Stored in this way, they are ready to be hung next season.



Two window spring bolts make nonsliding screens easy to remove. Below, loose joints may be reënforced in several ways. Use a turnbuckle brace to lift sagging screen doors

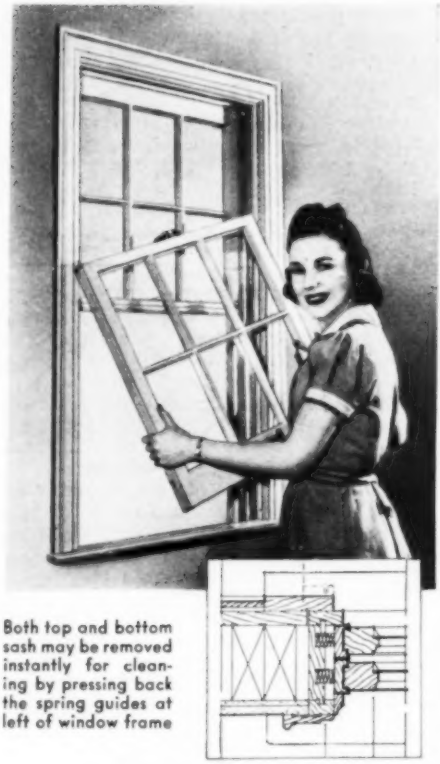




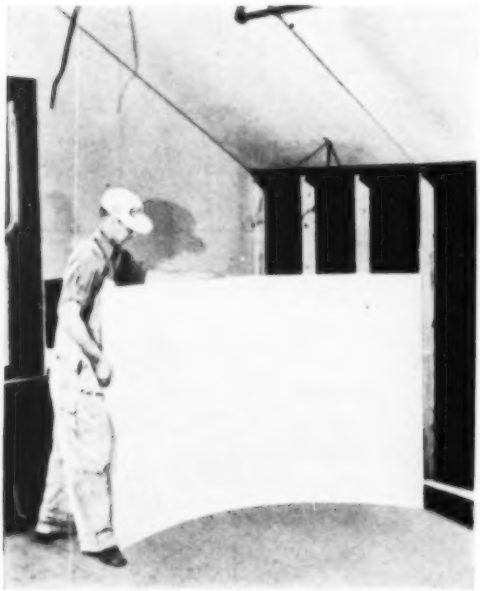
HOW TO APPLY NEW SCREENING

IDEAS for HOME OWNERS

REMOVABLE WINDOWS. For cleaning or substituting screens, windows of the type shown at the right can be lifted out bodily. They have no cords, straps, pulleys, or sash weights, but slide smoothly in zinc-alloy guide strips which are said to afford a positive and rattleproof seal against wind and water. The right-hand strips are stationary; the others are attached to concealed springs which press them against the sash sufficiently to hold the latter in any desired position. This construction automatically compensates for settling of the house or warping of the window frames, and the windows cannot stick during damp weather. It is claimed that the weatherproof fit effects a saving in household fuel bills. A user reports that during a two-day hurricane not a drop of water entered his house through the jambs, sills, or muntins of windows fitted with such removable sash.



Both top and bottom sash may be removed instantly for cleaning by pressing back the spring guides at left of window frame

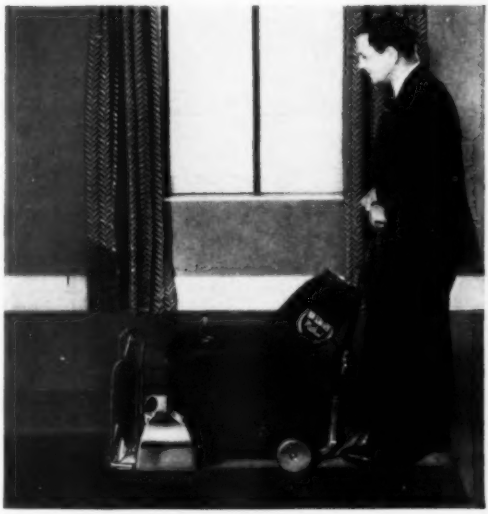


FLEXIBLE ASBESTOS-CEMENT WALL BOARD, which may be bent to a four-foot radius, is also more easily installed because it may be nailed, sawed, hammered, or perforated without danger of cracking or splitting. Made of asbestos fiber and Portland cement, it is rotproof and highly fire resistant. It is claimed that the flame of a blowtorch directly applied will not ignite it. Rats and termites cannot affect it. It may readily be painted or papered to fit any color scheme, and is also available in 4″ by 4″ squares resembling tiles. Stock thicknesses include 3/16″, ¼″, and ⅜″, and sheets are 48″ by 48″ and 48″ by 96″. Unfinished metal strip for use with this wall board is available to suit all requirements.

A PET DOG can open a screen door from the outside with a handle made from a metal shoehorn. Bend it at the neck and drill a second hole so that it can be screwed to the door at a convenient height.

MODERN VENTILATOR. This device operates something like a Venetian blind and permits the air to be directed either upward or downward. To alter the direction, the ventilator is removed and turned upside down. When the louvers open downward toward the outside, not even a driving rain can force water into the room. The ventilator is manufactured in four different colors and constructed entirely of steel. It is instantly adjustable for width and may be permanently affixed or left removable.

A RUG-CLEANING ATTACHMENT for twist-pile rugs and carpets has been developed for use with a standard rug-cleaning machine. The attachment evenly spreads a specially developed moist powder over the rug. The amount distributed may readily be regulated, and a hopper holds sufficient cleaning compound to treat several large carpets. The powder is brushed into the fibers and allowed to remain for from one to two hours, after which it is removed by a vacuum process. Twist-weave rugs have always presented a peculiar cleaning problem, and both the powder and the spreading attachment are the result of more than two years experimentation. The attachment can be removed if rugs are to be treated with the usual liquid compound instead of the new moist powder.



Try for a Prize in Our

$1000 CONTEST

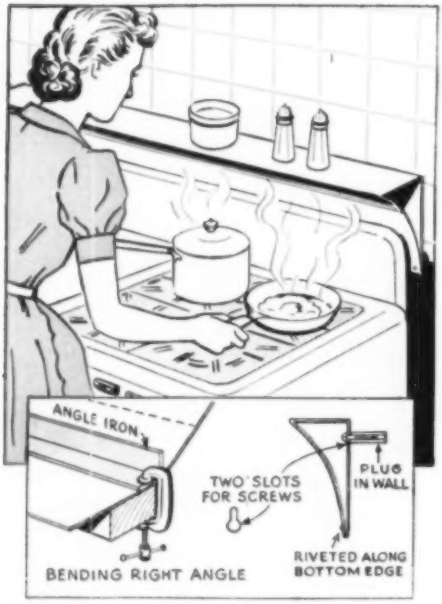
on "The Home You'd Like to Build"

LAST CALL for our home-planning contest! You have only up to April 15. All entries must be mailed on or before that date.

New readers—or old readers who have for any reason missed the announcements in the preceding three issues—still have ample time to enter, provided they get to work promptly after this issue goes on sale. Space does not permit repeating the rules in full, so reference should be made to the February, March, or April issue, which can be found in practically all public libraries. Each of those issues contains all details of the contest.

The first prize will be a cash award of $500 or, if you prefer, the services of an outstanding architect to draw the plans and supervise the building of your home. Second prize is $200 in cash, third prize $100, fourth prize $50, and fifth prize $25. There will also be 25 prizes of $5 each. In case of ties, duplicate prizes will be awarded to the tying contestants. The contest is open to all except professional architects and employees of Popular Science Publishing Co., Inc., and their families. Address the House Planning Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y.

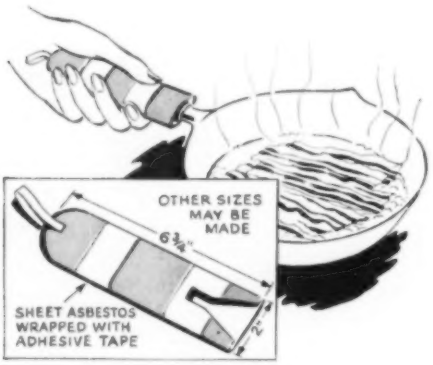
KEEPING THE HOME



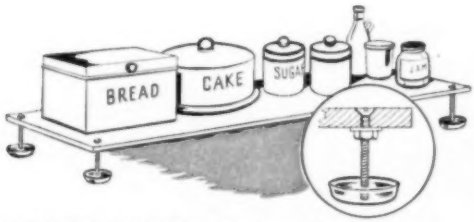
KEEPING THE KITCHEN CLEAN. To prevent discoloration of the wall by heat and grease from the stove, a deflector and shelf can be made from medium-gauge sheet metal. A piece of angle iron, some clamps, and a board will simplify bending. Slots fitting over screws in the wall make it easy to remove

MARKING THE COVER OF A TEAKETTLE will aid in replacing the cover properly without first having to turn it over and look for the lip. Use a good enamel matching the color of the handle

REMOVING STUBBORN STOPPERS. Stoppers of glass that are stuck or "frozen" often can be removed by using a nutcracker. This exerts an upward pressure on the sloping sides of the stopper

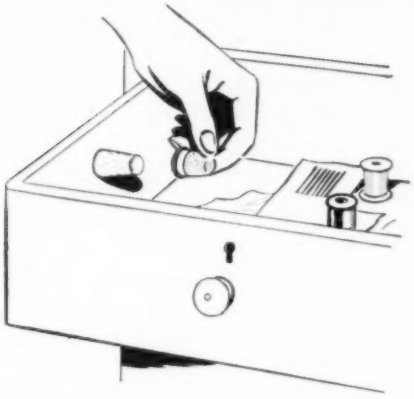


BURNS FROM HOT PAN HANDLES can be avoided with a holder made of sheet asbestos folded or rolled to the proper size and fastened with tape. An oilcloth covering, also held with adhesive tape, will add a decorative finish and make it wear longer

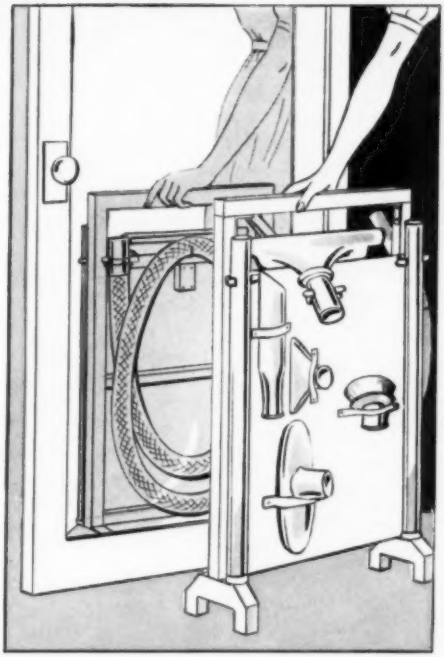


ANTPROOF PLATFORM. To keep the ants from raiding your larder, make a shelf of plywood with 2" brass machine screws for legs. Set these in can covers or coasters filled with water or kerosene

SHIPSHAPE



THIMBLE HOLDER. A cork nailed or glued to the inside of the sewing drawer will make a holder that will keep a thimble where you can find it



A VACUUM CLEANER ATTACHMENT RACK. This lightweight holder provides a convenient way to carry or store your cleaner attachments. The frame is 1" square stock, 25" high and 14½" wide; the panel is ¼" plywood, glued and nailed to the frame. Each "wand" rests on a tapered dowel screwed to the foot of the frame, and the other fittings are held with spring clips or strips of elastic

DOES A NOISY DRAIN PIPE disturb your sleep at night or spoil your concentration when you are trying to work in rainy weather? One way to quiet it is to place a sponge in the drain in a position to catch the drip and stop the clatter. Fasten it in place with waterproof glue or cement

BUTTERMILK brushed over an oil painting and allowed to dry makes a protective coat that is invisible. When the painting needs cleaning, wash off the buttermilk and apply a fresh coat

Typewriters will last longer if erasing is done this way, with the carriage shifted to either side so bits of dirt won't fall in the mechanism and cause wear

First Aid for Typewriters

By R. M. KASTEN

Editor's Note: Mr. Kasten is the plant foreman of the Wholesale Typewriter Company, New York, the largest typewriter rebuilding concern in the world, and has supervised the repairing and reconstruction of hundreds of thousands of machines of all makes.

SO YOUR typewriter creaks and groans, prints letters half clogged up and askew, responds to your touch as if it were lubricated with glue? Don't imagine for a moment it is the fault of the dealer, the manufacturer, or the mechanism! Modern typewriters are constructed to take the worst beating of any precision machine of ranking quality in the world. When a machine acts up, ten to one it is due to your own neglect.

Some typewriter owners don't raise a finger to keep their machines clean. And dirt and dust are factor number one in putting a machine out of business. They not only *slow* down parts, but, acting as abrasives, they also *wear* them down.

You don't leave the back off your watch, but do you cover your typewriter? There is equal need for doing so. You should also regularly wipe off exposed parts with a soft cloth, and brush out the interior with a long-bristled brush, or blow it out with the blower attachment of your vacuum cleaner.

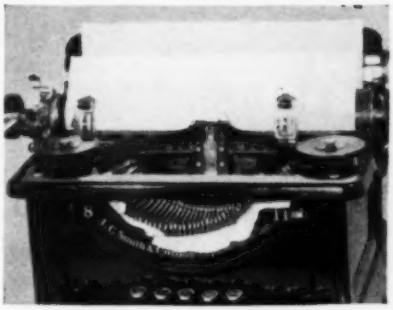
Most operators, by erasing over the type guide, dump particles of dirt straight into the vital mechanism. To avoid this, shift

the carriage all the way to one side, turn the line to be erased to the top of the cylinder, and brush the rubber and paper particles outside the machine where they can do no harm. Also, avoid rolling dust-laden paper into the machine.

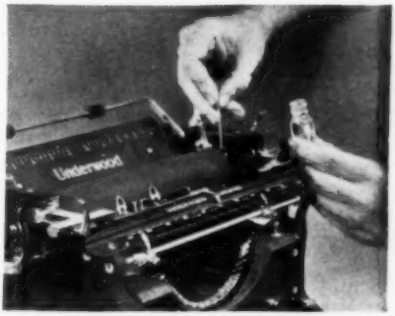
Typewriter type is so easy to clean there is no excuse for clogged letters. Brush them with a dry brush after each day's use and they will stay bright indefinitely. Caked ink may be removed with type putty, alcohol, carbon tetrachloride, or one of the proprietary dry-cleaning fluids, applied with a brush. Press the type putty onto the type, peel it off, and the caked ink comes with it. If you use a liquid, first lift the type and put paper under it to prevent dirt from dripping into the machine. Wipe the type dry with a cloth before using the machine again.

Squeaks, sticking keys, and a carriage so lazy you are sure the mainspring has worn out, may often be cured by a single properly placed drop of oil. Any ordinary light machine oil will do, but regular typewriter or sperm oil is best. Apply it sparingly—as much as will cling to the end of a toothpick will do—and wipe off all excess. Overoiling is as bad as underoiling, because exposed oil soon becomes like sticky fly paper and collects dirt.

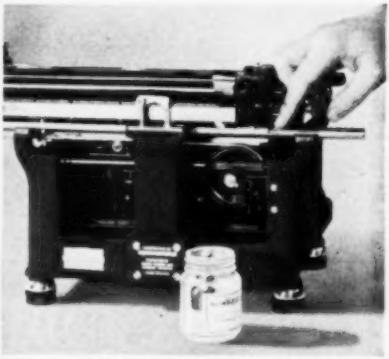
Where should you oil? The bearing at each end of the cylinder, the little roller that engages with the ratchet wheel to lock the lines in position, and all the ribbon-spool shafts and gear shafts connected with them, need oiling. Parts that show a tendency to rust may be



When using type-cleaning fluid, be sure to place paper under type to prevent dirt from falling into the machine. Dry the type with a rag before removing paper. Don't forget . . .



. . . that a little oil in the right places will add to the life of any typewriter. A toothpick is an excellent dropper for applying oil



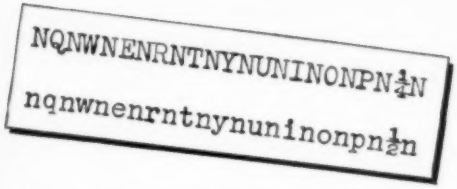
A typewriter having a "wayrod" needs a dab of petroleum jelly applied to it at times, as above

Yanking paper out as shown at the left puts a shine on the cylinder and causes the paper to slip. Always roll it out

Hold the space bar down and press each key to see if its type bar is centered in the guide

wiped over occasionally with a cloth moistened with oil, but remove all excess with a dry cloth. Squeaks must be tracked down individually, and a drop of oil applied at the source.

If the carriage runs on a steel "wayrod" (as, for example, in all standard Underwood machines), it can maintain its zip only if this rod is kept clean and occasionally lubricated with a little petroleum jelly. Move the carriage far to one side and place a smear of this lubricant on the rod between the carriage bearings. Shift it to the other side and repeat. Then depress the carriage release lever and run the carriage back and forth a few times to distribute the lubricant.



Check the alignment of the type by striking each character between the straight-sided letter "N"

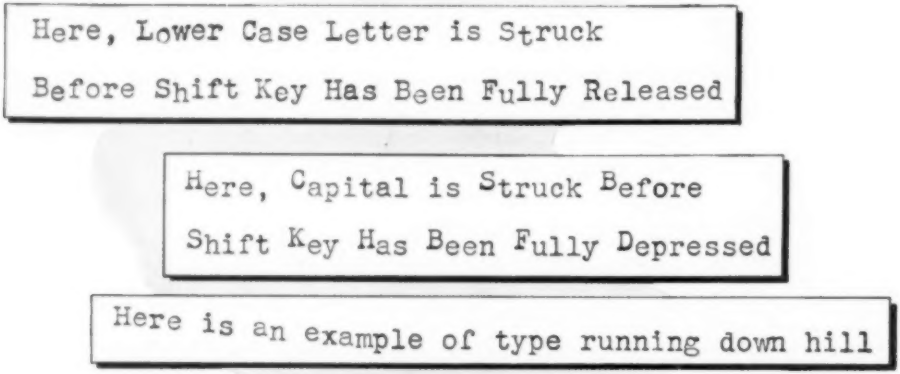
On portable machines, and standard machines in which the carriage runs on ball bearings in a track, this track should *not* be oiled, but should merely be wiped clean.

Another part *never* to be oiled is the slotted casting through which the type bars pivot. Oil in these slots would soon gum them up and bog down the whole machine. Shun all rubber parts, also, with your oil can. Oil deteriorates the rubber, and may leave its smear on your paper for months to come.

Have you paper-slipping trouble, from a cylinder worn smooth? Maybe you helped make it that way by a common sin of operation—disengaging the release lever and ripping the paper out with a jerk. This imparts a beautiful shine to the cylinder. If you want the cylinder to last longer, always roll the paper out by the knobs.

Cylinders and feed rollers may be cleaned, and the rubber rejuvenated, by wiping them with denatured alcohol. Just do this when necessary, as too much alcohol counteracts its own good effects. If the feed rollers are worn smooth, a light sandpapering will restore their grip.

Where mechanical adjustments on a typewriter are concerned, a good rule is to leave


Here, Lower Case Letter is Struck
Before Shift Key Has Been Fully Released
Here, Capital is Struck Before
Shift Key Has Been Fully Depressed
Here is an example of type running down hill

Type that prints heavier on one side than the other, or does not print vertically, can be straightened by the use of two pairs of pliers, one to hold the type bar in place, the other to bend the type. Vertically misaligned type requires special tools for straightening, and the skill of a trained mechanic

You can adjust THIS condition

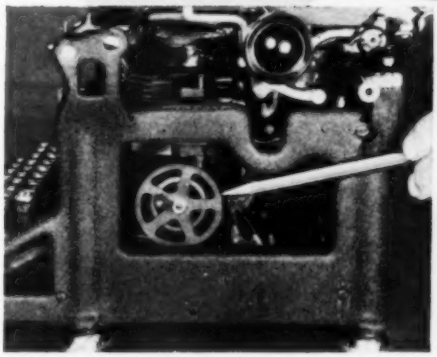
Do not try to correct THIS condition

them strictly alone, unless you are a typewriter mechanic or have sufficient mechanical ability to understand what you are doing. Most adjustments, once properly set, need never be changed during the life of the machine. Many common troubles, resulting in imperfect printing of type, are caused by avoidable faults in operation rather than by a defective machine. Studying these faults, and correcting them, may improve typing immediately.

Write a few lines for a test. Does the type print high and low? Are the letters spaced evenly? Now make a check on the alignment of the individual letters by carefully striking each character on the keyboard between the straight-sided letter "N." If the letters are still high and low, still spaced unevenly, they need mechanical adjusting. If they are not, the fault lies in an uneven touch or an erratic rhythm in your typing, or both.

Do letters in a line sometimes start nicely, then run downhill? This can't happen if you use the line-spacing lever, instead of rolling the paper through with the cylinder knob. In the latter case, the roller that locks the spacing of the lines may come to rest on top of a ratchet tooth, instead of settling between two of them. When the machine starts, the vibration gradually jars the cylinder around until it reaches its normal position—dropping letters as it turns.

Capital letters higher than the following lower-case (small) letters are a common example of lack of synchronization in typing. The capital is struck before the shift key has been fully depressed. When the succeeding lower-case letter is lower than those which follow it, this lower-case letter has been struck before the shift key was fully released. The remedy in both cases is obvious.



If the ribbon does not move, possibly the pawl on the ribbon-operating ratchet wheel has been bent

When type bars collide heavily, as they sometimes do in irregular typing, one or both bars may be bent sideways and may subsequently stick in the type guide. Or they may rub against the side of the guide and soon wear thin. So, periodically, type should be inspected for correct alignment in the guide. To do this, hold down the spacing bar, and press each key gently and evenly, watching the position of each type as it enters the guide. If a bar does not enter exactly in the center, but rubs on the side of the

Key tension on many standard typewriters may be changed by adjusting spring-tension screws for individual keys. A half turn to the right makes the touch heavier, to the left, lighter

guide, it should be bent with the fingers until it enters properly.

If type slants sideways in printing, or prints more heavily on one side than the other, any fair mechanic armed with two pairs of pliers can fix it. Hold the type bar, close below the type, with one pair of pliers, and firmly twist or bend the type with the other. Type that prints high or low, or lighter on the top than the bottom, however, presents a job for the service man! Great skill, and tools that exert tremendous pressure, are needed to adjust type in an up-and-down direction.

When the ribbon fails to move, look for the ratchet wheel which should move it and see if a too-brisk cleaning, or an accidental bang, has knocked the little pawl which turns the ratchet out of place. If it does not enter the ratchet teeth enough to turn the wheel each time a key is struck, it should be bent back into position. On machines in which the ribbon mechanism is geared to the carriage movement, this advice would not apply.

Does the key tension of your machine seem too heavy or too light? This tension is carefully adjusted at the factory and should remain in adjustment indefinitely, but sometimes it may be desirable to change it to suit the temperament of an individual operator. In some new machines it may be altered by a simple lever. On most standard machines the action may be adjusted by individual key spring tension screws. To make the action heavier, turn each screw half a turn clockwise. To lighten it, turn each screw counterclockwise.

Unless a typewriter has been so long neglected that its vitals are clogged with dirt and grease beyond the brush-out stage, it need never be given the thorough internal cleaning now to be described —at least until it is ready for complete overhauling or rebuilding. If you have such a machine, however, such a cleaning might bring it back to life.

The cleaning fluid is gasoline mixed with five percent of machine oil, which is added to help retard rust on the cleaned parts. If your knowledge of mechanics makes it possible, remove the carriage to prevent the cleaning mixture from getting on the rubber parts and to allow greater access to the interior. If you can't manage this removal, at least take off the rubber feet of the machine, cover the cylinder with paper, and remove the ribbon.

Stand the typewriter in a pan containing the gasoline—being careful to keep away from all fire—and run the liquid through all the parts with the help of a long-bristled brush. When the cleaning is finished, wipe off all excess liquid, and reoil parts that require special lubrication.

Here again it is necessary to emphasize the importance of applying oil lightly and judiciously. If this is done and the machine is kept clean, it is certain to give much longer and more satisfactory service.

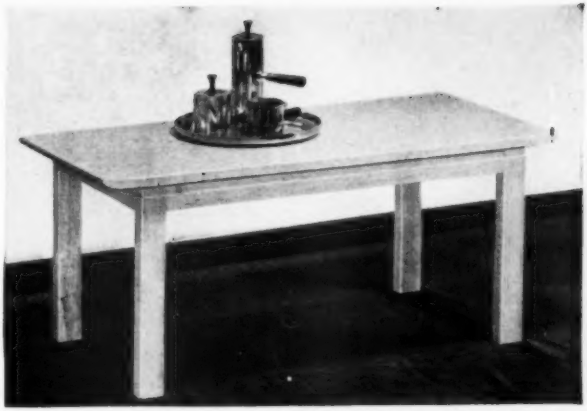
Before giving a machine a bath in gasoline with some machine oil added, remove rubber feet, ribbon, and if possible, the carriage. Above, the carriage has been removed and the draw-band end is being anchored to the frame

Use a large pan to give a machine its bath, and run the liquid through the mechanism with a long-bristled brush. Afterwards carefully wipe the typewriter as dry as possible with a cloth

MODERN COFFEE TABLE

By JOSEPH ARONSON

Author of
The Encyclopedia of Furniture



Of white oak, the table is finished very light in the latest style

THE distinctive feature of this coffee table is a quality of softness often lacking in modern designs. This is obtained by the slight curvature at the ends of the top and the molded edge across the ends.

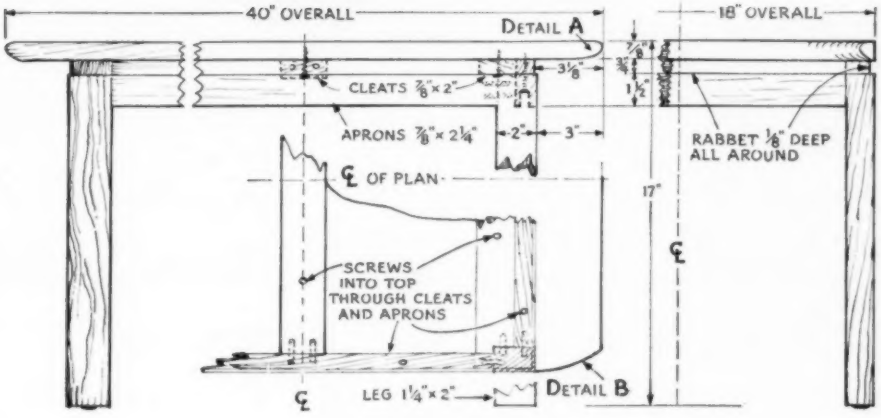
The rabbet or sinkage, ⅛" deep by ¾" wide, under the top can be cut into the apron and legs either before or after they have been assembled. The top, which may be glued up from stock of any available width, should be screwed to the base so as to permit the wood to move slightly as it expands and contracts.

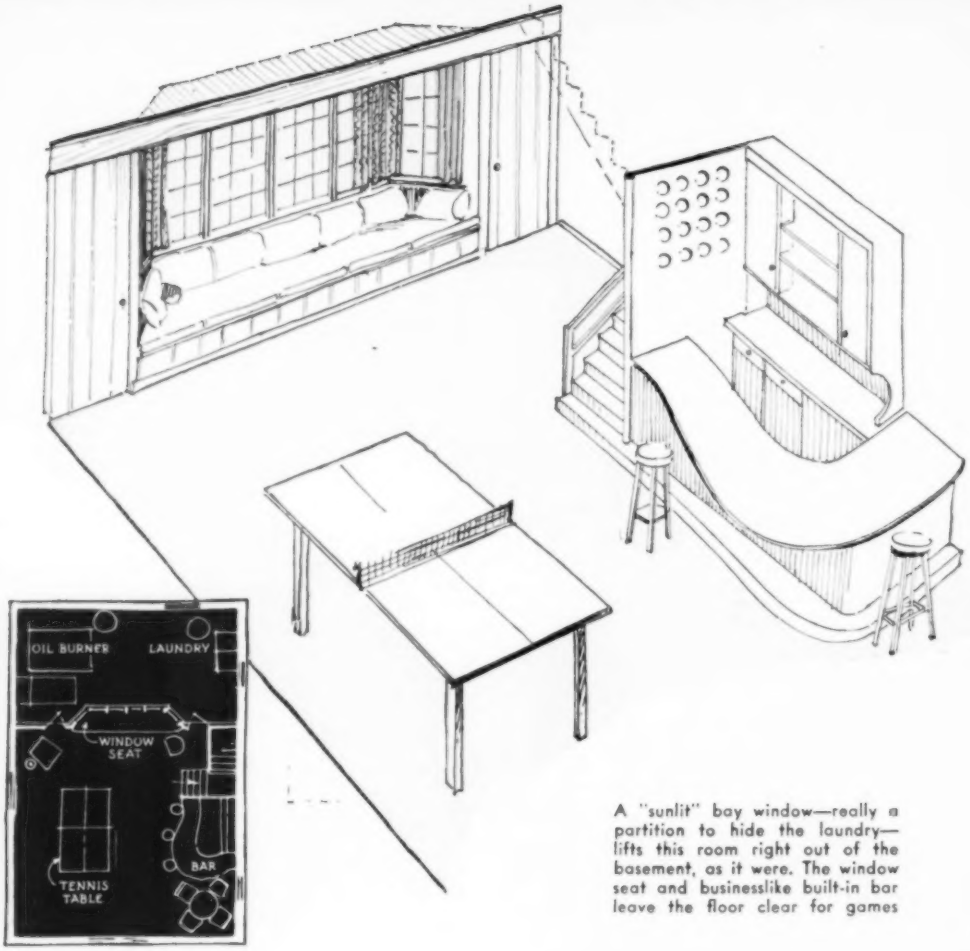
White oak was used for the model illustrated. The wood was sanded as smooth as possible and given a filler coat of clear brushing lacquer. This coat was sanded with No. 2/0 flint paper and then rubbed with No. 3/0 steel wool until hardly a trace remained, except in the grain. A second coat was applied, and this was finally waxed and rubbed with a piece of old carpet. A high-grade automobile paste wax was used, but any hard-drying carnauba furniture or floor wax would serve the purpose.

LIST OF MATERIALS

No. Pc.	Description	T.	W.	L.
1	Solid oak top	⅞	18	40
4	Oak legs (rabbeted top)	1¼	2	16⅛
2	Oak aprons (rabbeted)	⅞	2¼	30
2	" " "	⅞	2¼	15½
1	Center cleat	⅞	2	16¼
2	End cleats (cut to fit leg)	⅞	2	16¼

NOTE: All dimensions are given in inches.





A "sunlit" bay window—really a partition to hide the laundry—lifts this room right out of the basement, as it were. The window seat and businesslike built-in bar leave the floor clear for games

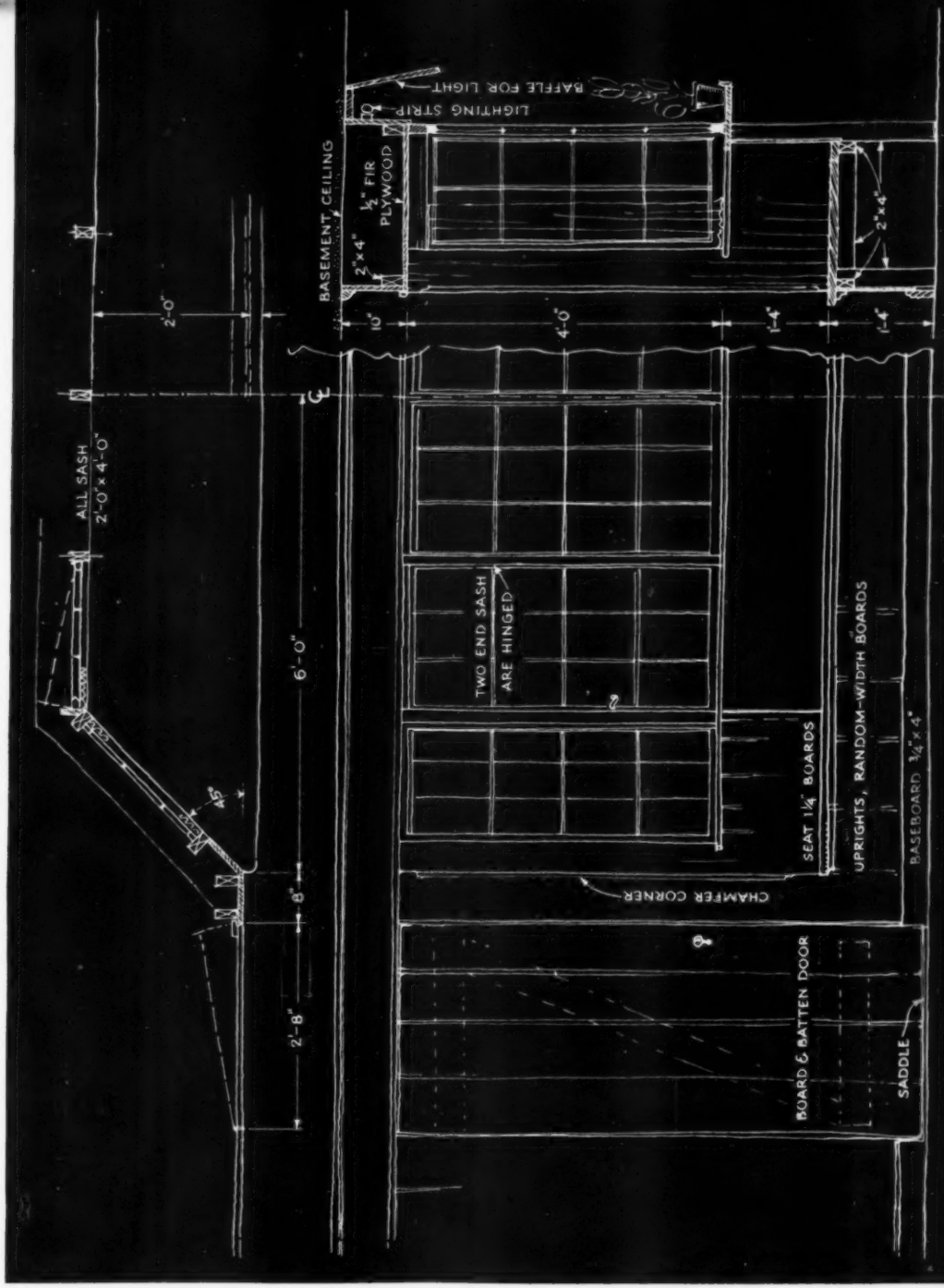
Basement Recreation Room

DESIGNED AND ILLUSTRATED BY JOSEPH ARONSON

MAKE the most of your basement! This typical basement is now a comfortable recreation room, with no hint of the laundry and heating apparatus. The separating partition is no mere wall; it is built to form a bay window with a deep, roomy window seat. The windows are glazed with semi-opaque or factory-ribbed glass. Above them, on the back of the partition, is a row of strip lighting with a baffle panel to reflect the light down on the windows and create a sunlight effect. The walls can be made of pine boards or plywood panels.

The dimensions shown are necessarily subject to change to suit the house, but the height of the seat and back should not vary from the drawing. These heights allow for pad cushions and back pillows. The doors will also vary in each case, both as to position and size.

Sketches for the bar and cabinets, as they were worked out for this basement, will appear in the June issue. The same issue will carry an article by Ralph G. Waring on new ways to finish pine and plywood.



Semi-opaque windows are illuminated by concealed lamps. Ordinary small bulbs or mellow-hued fluorescent tubes are used. The baffle panel is painted white to reflect light downward through the glass

WIRING A HOME WORKSHOP *for* LIGHT AND POWER

PART TWO—BY EDWIN M. LOVE

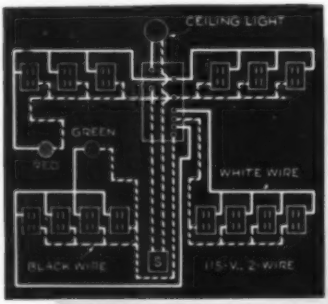
ANY home workshop can be wired for light and power by the approved methods shown in the accompanying illustrations. It is here assumed that the layout is identical with the model arrangement suggested in the preceding installment, but the principles will be the same no matter how the plan is modified to suit individual conditions.

The pictorial wiring plan below suggests in a general way how flexible cable or conduit can be laid out with a minimum of bends. In some cases outlets for bench lights might better be placed in the ceiling, although attachment plugs are more likely to fall out of ceiling receptacles, and heater pipes or ceiling lumber racks may interfere with their use.

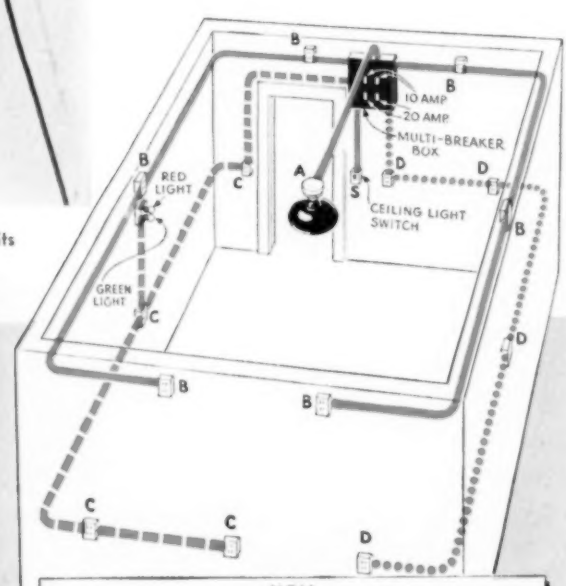
Before buying electrical material, mark the outlet positions and take accurate measurements of the cable required, allowing about 6″ at each end for trimming, and some for turns and waste as well. A fiber bushing is needed for each cable end, and a connector as well, unless the boxes have built-in clamps.

If flexible armored cable (BX) is used, prepare the ends as in the drawings. Carry the cable across studs and ceiling joists through holes bored for the purpose, or for surface work staple it to running boards

Colored pilot bulbs glow in "live" circuits



Two-wire diagram. The motor and light circuits are separate



KEY

(A) CEILING LIGHT, 115 V., CIRCUIT NO. 1
(B) DUPLEX CONVENIENCE RECEPTACLE, 115 V., CIRCUIT NO. 2
(C) DUPLEX CONVENIENCE RECEPTACLE, 115 V, CIRCUIT NO. 3
(D) DUPLEX CONVENIENCE RECEPTACLE, 115 V., CIRCUIT NO. 4
OR
(C) SINGLE 3-WIRE RECEPT. 230 V, CIRCUIT NO. 3
(D) SINGLE 3-WIRE RECEPT 230 V, CIRCUIT NO. 4
(INSTALL TWO RECEPTACLES IN SINGLE BOX AT EACH POINT, IF NECESSARY)

nailed across or between the timbers. Run the BX along the sides of wooden structural members as necessary.

Wiring to be installed in finished walls and ceilings can usually be "fished" between openings cut in the surface. Pass in an electrician's "snake wire" attached to the cable and have a helper catch the end through the next hole.

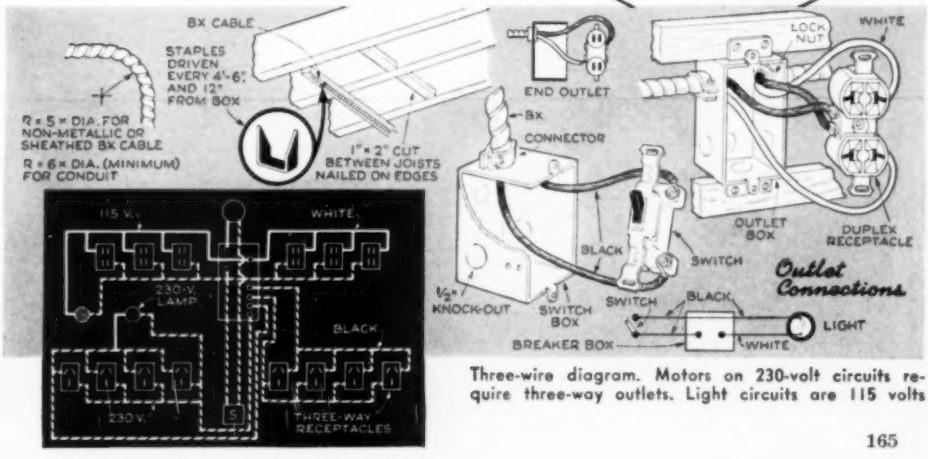
For concealed wiring choose deep boxes, which provide ample room for wires and fittings, and let them project a distance equal to the thickness of the wall board or other material to be used on the walls. For exposed work, the shallower "utility" boxes are neater. Both kinds have several "knock-outs" or partly punched holes that can be opened as needed with a screw driver or by striking with a hammer claw. Insert a fiber bushing in the cut end of the armor and bring the end well into a connector, so that it will clamp firmly on the armor; then tighten the lock nut until the corners bite into the metal.

A material much favored now, especially for fished work, is nonmetallic sheathed cable. This is installed like BX, except that connectors have clamps which close to a smaller opening, and metal straps replace staples.

In some localities, ordinances may require rigid conduit for cellar wiring. In this case use thin-walled threadless tubing, which can be assembled with only a wrench. To prevent damage to insulation, ream out the burr from cut ends, and use a special bender to avoid flattening the conduit at the bends. For most work ½" tubing is used, and the Electrical Code allows this size to carry four No. 14 wires or three No. 12 wires. Install the tubing and draw the wires through afterward with a fish wire.

If the house is equipped with a three-wire

Bench outlets facilitate using soldering irons, gluepots, and the like. Flush mounting is best



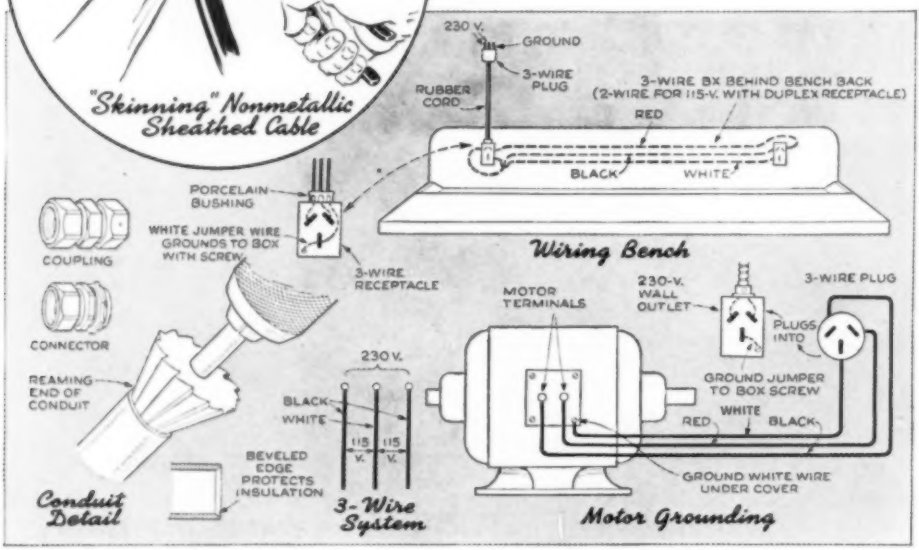
Three-wire diagram. Motors on 230-volt circuits require three-way outlets. Light circuits are 115 volts

Tighten connectors well to insure ground contact between the boxes and conduit or armored cable

115-230-volt service, the shop wiring is carried out as described, but the circuits are balanced in the panel or distribution box by dividing as evenly as possible on each side of the neutral wire. Between the neutral and either outside wire the potential is 115 volts; across the two outside wires it is 230 volts. If motors have interchangeable leads for either voltage, they should be connected to the 230-volt leads. Instead of a black and a white wire as for the 115-volt lighting circuits, two black wires are run to supply the motor outlets. If BX or nonmetallic sheathed cable with the customary black and white wires is used, the ends of the white wires in the boxes can be painted black to conform to this rule. The motor outlets should be of the polarized three-pole variety, requiring three-wire cords and attachment plugs which permit grounding the motors and machines to prevent accidental shock. These special receptacles also prevent ordinary 115-volt appliances from being plugged in.

The standard gauge for ordinary circuit wiring is No. 14, and it will safely carry 15 amperes, which is sufficient for the lighting circuits. For the motors, use No. 12 wire, which can be fused 20 amperes to allow for the heavy starting current.

When the wiring is installed, be sure all box and cable clamps are tight to insure a good ground connection through the armor or conduit. Bond the latter to a cold-water pipe somewhere in the cellar, using a piece of No. 10 wire and two soldered or approved clamp-type connectors.

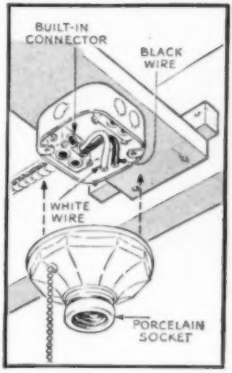


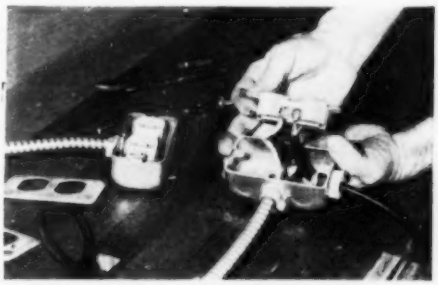
Although the plan shows a multi-breaker panel box, an ordinary fuse panel may be used if desired. With the former, however, an overload merely trips open a small circuit breaker which can be easily reset, while a blown fuse must be replaced. If fuses are decided upon, it is better to use those with a time-lag element for the motor circuits. They do not blow instantly on short-period overloads and thus allow for the heavy starting current; but on continued overload and short circuits, they blow like ordinary fuses.

Submains (supply wires) feeding the panel must be large enough to carry the sum of the loads on all branch circuits that are likely to be in use at one time. The Code allows a demand factor for calculating their size, but it is much safer to consult local authorities. For ordinary installations No. 10 or No. 8 will do. These wires must be carried to some suitable point for connection to the service. Whether it will be two- or three-wire will depend on the service entrance. In some cases, if the house lighting panel is supplied with large enough submains, connection for shop submains can be made to them. If not, they may have to be run to the meter board.

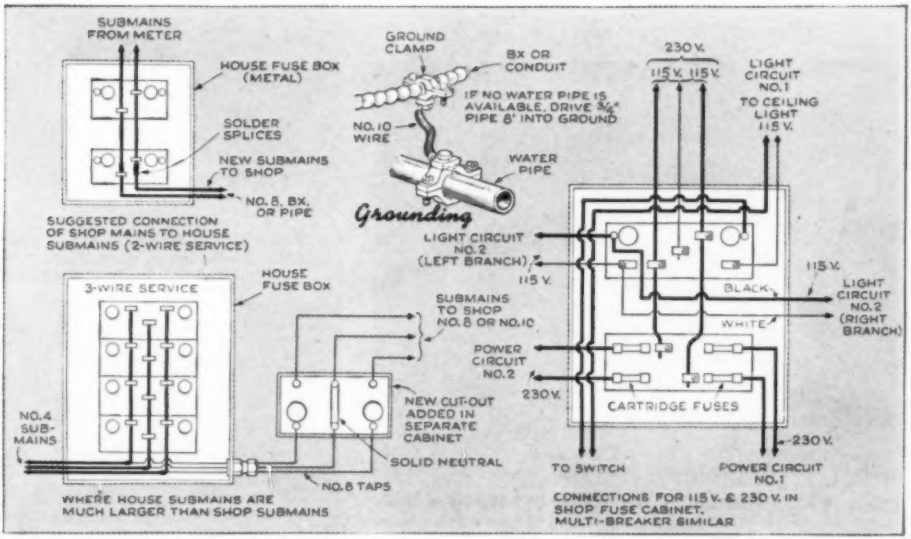
If the shop is in the garage or some other outbuilding, the supply wires should be large enough to avoid much voltage drop. Where a building is already wired but has submains smaller than No. 10, they should be replaced. Run the new wires as high above the ground as possible and use glass or porcelain insulators at each end to "dead-end" on. The circuit is continued at each end by tapping on wire of the same size so as to form drip loops.

For better appearance the supply wires can be run underground, but lead-covered wires in conduit must be used. For a two-wire system, only one lead-covered wire is required; the other or grounded wire may be rubber-covered.





Fasten wires, then mount receptacles within outlet boxes with two screws. Cord taps must pass into the boxes through porcelain bushings


SUBMAINS FROM METER
HOUSE FUSE BOX (METAL)
SOLDER SPLICES
NEW SUBMAINS TO SHOP
NO. 8, BX, OR PIPE
SUGGESTED CONNECTION OF SHOP MAINS TO HOUSE SUBMAINS (2-WIRE SERVICE)
GROUND CLAMP
BX OR CONDUIT
IF NO WATER PIPE IS AVAILABLE, DRIVE ¾" PIPE 8' INTO GROUND
NO. 10 WIRE
WATER PIPE
Grounding
230 V.
115 V. 115 V.
LIGHT CIRCUIT NO. 1 TO CEILING LIGHT 115 V.
LIGHT CIRCUIT NO. 2 (LEFT BRANCH)
115 V.
3-WIRE SERVICE
HOUSE FUSE BOX
SUBMAINS TO SHOP NO. 8 OR NO. 10
POWER CIRCUIT NO. 2
230 V.
NEW CUT-OUT ADDED IN SEPARATE CABINET
NO. 4 SUB-MAINS
SOLID NEUTRAL
NO. 8 TAPS
WHERE HOUSE SUBMAINS ARE MUCH LARGER THAN SHOP SUBMAINS
BLACK
WHITE
115 V.
LIGHT CIRCUIT NO. 2 (RIGHT BRANCH)
CARTRIDGE FUSES
230 V.
TO SWITCH
POWER CIRCUIT NO. 1
CONNECTIONS FOR 115 V. & 230 V. IN SHOP FUSE CABINET. MULTI-BREAKER SIMILAR

New Appliances

SAFETY AND CONVENIENCE are combined in this gas range. It has an extensible top below and in front of the burners and burner controls placed out of children's reach

PALETTE TRAY. Keeping a firm grip on a serving tray even when using only one hand is simple with this mahogany server shaped like an artist's palette

NONDRIP MILK BOTTLE CAP. Milk will not spatter, drip, or run down the side of a bottle that is fitted with this cap

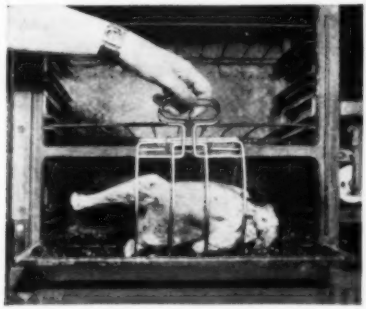
SCRUB-PAIL CARRIAGE. To lighten the chore of floor scrubbing, use this "dolly," which has casters enabling you to move the scrub pail around without scratching the floor

CURVED INDENTATIONS in a cup-shaped aluminum shaker make it effective for combining hard-to-mix ingredients

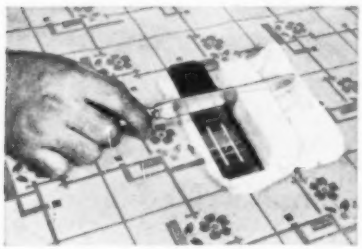
for the Household

SEWING SIMPLIFIED. Pegs to hold spools in place, pincushion, and ruler are attached to a light plywood lapboard which keeps sewing needs within reach

TURNING ROASTS during cooking or lifting them from the pan when they are done is made easy with the roast lifter illustrated. Four sizes are available



ELIMINATE GUESSWORK in cutting butter with scale on back of the steak meter shown in April P.S.M. (p. 170)



CONTROLLED COMFORT. Too hot or too cold? Turning a dial on a window-type air conditioner now on the market will provide you with either warm or cool air, as you wish

REFRIGERATORS WITH COLORED INTERIORS are now available to add to your kitchen's "eye appeal." Harmonizing plastic panels in pastel color combinations are used

Folding Wall Brackets

TURNED ON THE LATHE

THE unique construction of these beautiful wall brackets challenges the skill of anyone interested in wood turning, and permits them to be folded flat for packaging.

Mount a disk of ⅞" walnut or other hardwood, 8½" in diameter, on waste stock. For undercutting the ring, make a special tool from the tang of a heavy file. The recess that holds the bottom of the ring in its supporting position is turned out next, as shown in the drawing. After turning, sand and finish the front with shellac.

Next glue a piece of waste stock to the center portion. Remount the work in the lathe, turn off the first piece of waste stock, and finish the flat side. Finally, remove the small piece of waste stock.

On the jig saw, cut across the disk as shown. Use dowels to hinge the two sections.

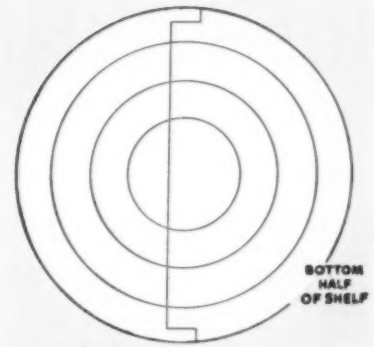
Turn a piece of waste stock the right size to mount the ring for finishing. The ring is finally held to the upper portion of the bracket with a leather thong, which is pegged and glued as indicated.

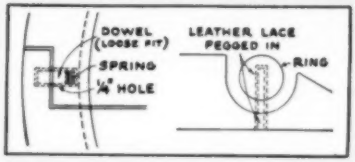
If measurements are accurate, the ring should be of the proper diameter to hold the shelf at a right angle. The ring may be made a little large, and later sanded if necessary to bring the shelf square.

Drill and countersink a hole in the center for mounting the bracket upon the wall.—BENJAMIN NIELSEN.

Clocked Project

Average Time 7½ hours





Springs permit hinge pins to be pushed back as the parts are being assembled

The ring is fastened at the top by a leather thong through the shelf side

Turn and finish in the lathe, and saw apart. The shelf is shown at the left

Treble-Clef Bud Vase

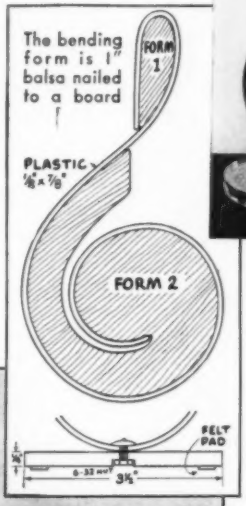
IN COPPER OR PLASTIC

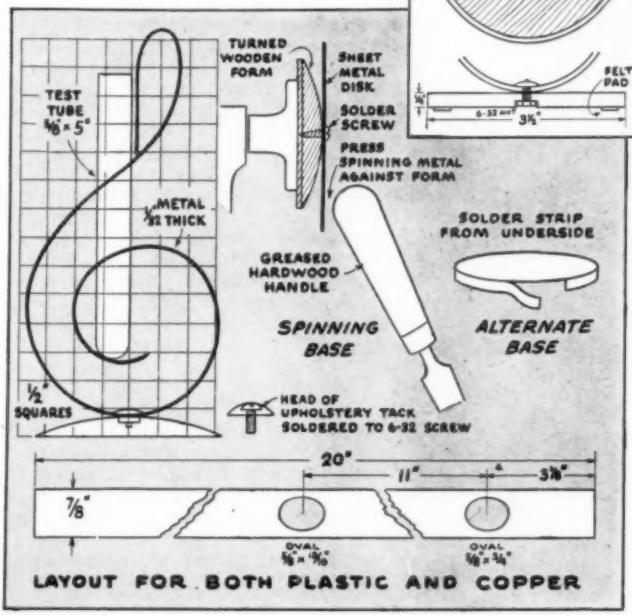
SCRAPS of material and a five-cent test tube form this whimsical little vase. Given dimensions are for a tube $\frac{5}{8}$" in diameter. To make the vase of metal, cut the oval openings with a jeweler's saw, file smooth, and finish the strip either by machine buffing or by rubbing to a satiny luster with 00 emery cloth. Make a full-size drawing of the scroll and shape the strip upon it. Tarnishable metals should be given a coat of clear lacquer immediately after bending.

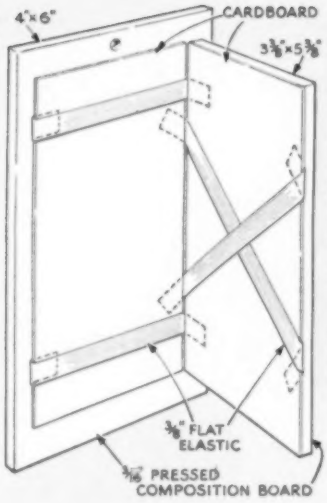
Plastic dimensions are the same, but the strip should be $\frac{1}{8}$" thick. Cut the holes undersize, file to size at the proper angles, and polish the entire strip. Nail the two parts of the bending form to a board. Soften the strip in hot water (or in an oven, if acrylic resin is being used) and start the bend at the inside of the spiral. Use extreme care in shaping the parts adjoining the holes. If necessary reheat faulty parts and hold in the desired shape by hand until cool.

The convex copper base is a simple lathe spinning. An alternative built-up base is illustrated. The plastic vase shown stands upon a disk of $\frac{1}{4}$" plastic. Solder a 6-32 brass screw into the head of a decorative upholstery tack, with stem removed; drill a hole in the spiral, and assemble with a nut. Glue felt under the base.—HARRY WALTON.

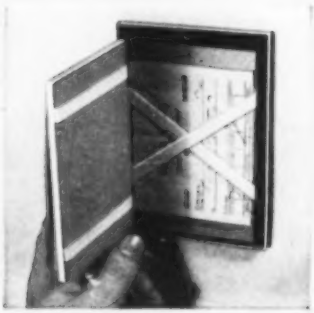
Wear gloves when shaping hot plastic. If the base is transparent, cement on three small felt pads to protect the undersurface. Before spinning the convex base, anneal copper by heating it to redness and quenching in water. Average time 3¾ hours

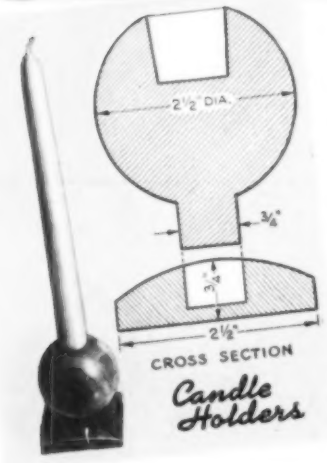






Kitchen Memo Pad





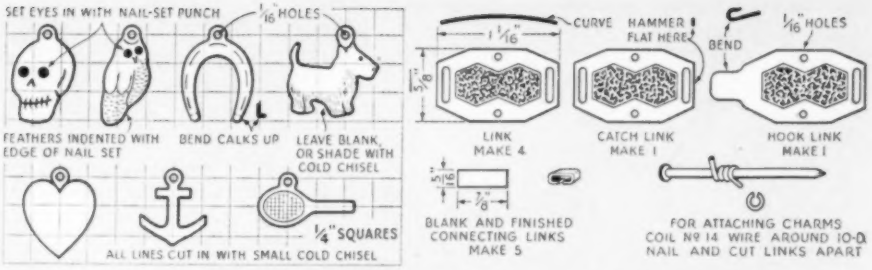
Candle Holders

WORKING TIME:

NOVEL KITCHEN MEMO HOLDER. This project is sure to arouse curiosity because of the ingenious way it works. It is necessary only to open the cover, insert the bill or memo to be filed, and close the cover against it. Upon opening the cover from the other edge, it will be found that the paper slip has magically become lodged beneath the elastic bands. A number of slips may thus be inserted.

Materials: 1 pc. 3/16" by 4" by 6" pressed composition board or very heavy cardboard for the back and 1 pc. 3/16" by 3⅜" by 5⅜" for the front; 2 pc. stiff cardboard 3⅜" by 5⅜"; 4 pc. ⅜" wide flat elastic tape, and a small memo pad. Attach ends of the elastic to the cardboard with cellulose cement, *stretching the tape somewhat so that it will be under tension.* Cement the cardboard "book" so made between the 3/16" thick front and back pieces, and apply narrow strips of tin foil to the edges of the latter with orange shellac. When dry, burnish the foil with a smooth, rounded instrument, and glue the memo pad to the cover. Craftsman's time, 1 hour; beginner's, 2 hours.

TURNED CANDLESTICKS. Material: Beautifully grained walnut such as is found in stumps, burls, and crotches. Glue a 2½" square of ¾" thick stock to a piece of waste and center it on the lathe faceplate. Turn the top to a smooth curve, but leave the sides square. Bore the ¾" hole and lay the piece aside, but do not remove from the faceplate. Now turn the ball-shaped holder. This may be done between centers, if no other faceplate


SET EYES IN WITH NAIL-SET PUNCH
1/16" HOLES
FEATHERS INDENTED WITH EDGE OF NAIL SET
BEND CALKS UP
LEAVE BLANK OR SHADE WITH COLD CHISEL
1/4" SQUARES
ALL LINES CUT IN WITH SMALL COLD CHISEL
1 1/16"
CURVE
HAMMER FLAT HERE
BEND
1/16" HOLES
5/8"
LINK MAKE 4
CATCH LINK MAKE 1
HOOK LINK MAKE 1
5/16"
7/8"
BLANK AND FINISHED CONNECTING LINKS MAKE 5
FOR ATTACHING CHARMS COIL No 14 WIRE AROUND 10-D NAIL AND CUT LINKS APART

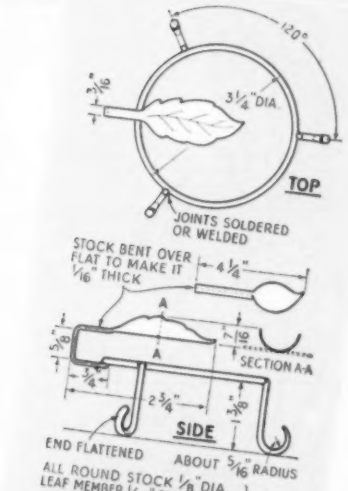
Charm Bracelet

ONE EVENING

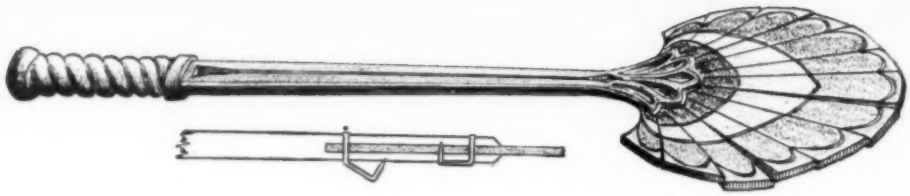
is available, by finishing the lower half of the ball and the projecting dowel completely, and rough turning the upper half before cutting off. Glue this part to the base, remount the faceplate, finish turning the upper half of the holder, and bore the tapered hole to fit the candle. Finish the piece while in the lathe, as far as possible. The square edges must, of course, be sanded and finished by hand. Glue felt or blotting paper to the bottom. Average time, 3½ hours each.

CHARM BRACELET. Material: 18-gauge nickel silver. Cut and file the links to shape, drill holes, and work out the slots by filing or sawing away the material between holes drilled close together. The design may be stippled in with a paneling punch, or with a hollow-end nail set and a center punch. Saw out the charms with a jeweler's saw and file to shape. Dot eyes of the skull and owl with red enamel. Average time: bracelet, 3 hours, charms ¾ hour each.

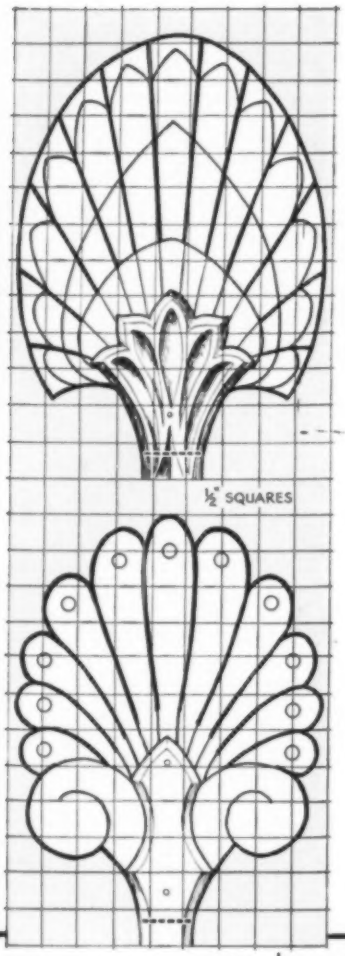
ASH TRAY. A small, brightly colored pottery dish is purchased, and the stand made to suit of iron, brass, or nickel silver. The parts are joined by soldering or welding. Tarnishable metal should be given a coat of clear lacquer. Jet-black enamel provides a pleasing finish on iron. Craftsman's time, 1¼ hours; beginner's, 2¾ hours.



Ash Tray



Leather Fly Swatters



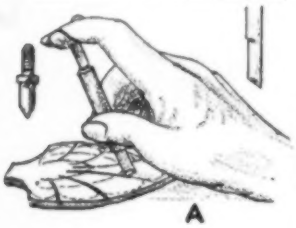
ORDINARY fly swatters are so ugly that they have to be kept out of sight, but it is not difficult to make a decorative one of leather.

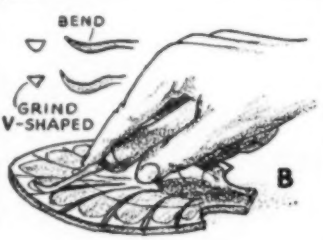
The handle may be any close-grained wood at least ⅜" thick and 15" long. It can be carved as shown or a plain stick tapering in width from ¾" at one end to ½" at the other. The leather should be 8-oz. uncolored tooling cowhide (⅛" thick) or very firm 6-oz. leather.

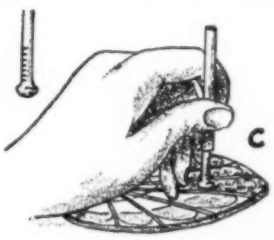
Soak the leather in warm water and let it dry to the tooling stage. Trace the design, drawn on thin, tough paper, on the grain side by using a hard pencil with considerable pressure. Cut out the shape with a sharp knife. Round cuts may be made with a wood-carving gouge. The heavy radiating lines are first cut about halfway through the leather with a swivel cutter, incising knife, or small, sharp cold chisel as shown at *A*. These cuts are then opened with a veiner *(B)*, which is easily made, if necessary, from a nut pick. The same tool is also used for tooling the lighter lines. With a knife, cut through the incised lines only. Leather dyes may now be applied, or the wood and leather left natural.

A background stamping tool is required, or a stamp made from a 40-penny nail *(C)*. A large nail set will also do. Stamp the leather almost all over, to compress and harden it. Do this on a leather worker's marble slab, if one is available. A hole may be punched in each tip, but is not essential as the swatter does not blow the fly away. Glue the leather into the handle saw cut; or, better still, fasten with two pins clinched over as in the above drawing. Occasional applications of leather polish will preserve the finished piece. An excellent polish is easily made by adding one part of warm water to two parts of liquid floor wax.

To make the swatters in quantity, carve the design in reverse in ¼" battleship linoleum. Set this against the grain side of the leather and put a cotton, wool-skin, or sponge rubber pad against the flesh side. Hold between boards and squeeze together in a letter press or under a heavy weight. This transfers the design. If you can make steel-rule dies, these will speed up the cutting out of the forms.—JOHN W. DEAN.







Cake Server or Cocktail Tray

ASSEMBLED IN ONE HOUR FROM DIME-STORE PARTS

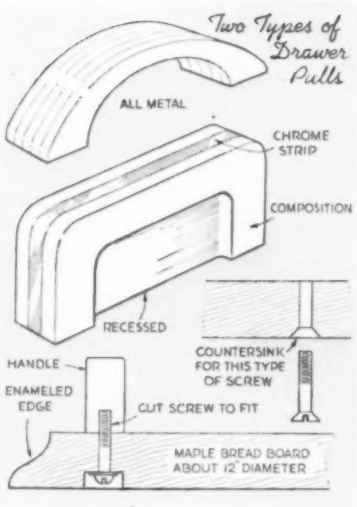
PARTS for this attractive cake server or cocktail tray, which can be made by anyone in an hour or less, cost exactly 57 cents and should be available in most large five-and-ten-cent stores.

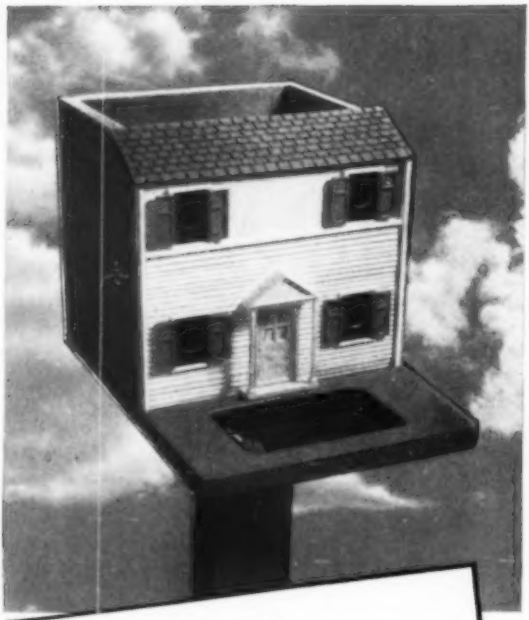
The base is a round or rectangular maple bread board or cutting board with an enameled edge. The one illustrated is about 12" in diameter and cost 25 cents. These boards are usually already sanded smooth, and have an attractive grain.

Also required are two modern drawer pulls, which come in many styles and colors, in metal or in plastic with chrome trim, at 10 cents each. Screws are included, but probably will have to be cut shorter. A 10-cent decalcomania (transfer) in the center adds a gay note if desired.

Countersink the board on the underside for the four screws so the heads will not protrude. Give both sides of the board one or two coats of either shellac or varnish stain, or use wax, and rub down. If wax is to be used, apply the transfer first.

So little varnish or other finish is required that the cost of this item (which is usually on hand) has not been included in the cost. The odd two cents went for a sales tax.





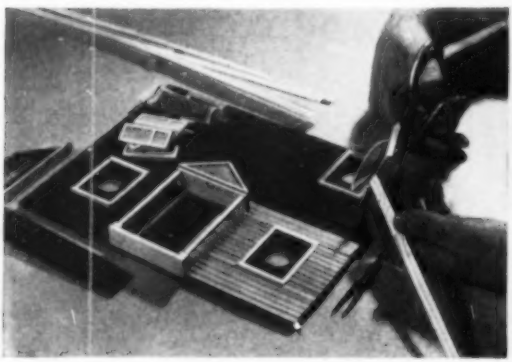
BIRD HOUSE WITH BATH

By KENNETH MURRAY

DESIGNED for comfort, this 1941 style bird house has a sunken bath in its front yard. A reservoir tank stores rain water and automatically meters it into the pool. Where rainfall is infrequent, the tank may be refilled by hand occasionally, so that water will be available to birds that might otherwise lack it. Easy access to water will attract birds to the house.

The design was adapted from one shown in connection with the POPULAR SCIENCE Home Planning Contest (see P.S.M., Feb. '41, p. 140). Measurements are given for a wren house, but may be altered for other birds. The house front is a replica of a Colonial home, with entrances to four rooms via window openings. Behind the rooms is the water storage tank, which receives rain water from a V-shaped sunken roof hidden behind the narrow shingled roof.

The front is cut from a piece of "tempered" pressed composition wood 3/16" by 8¾" by 11". (The same material is used for the roof pieces.) On a bench or band saw cut narrow strips of wood for siding, windows, shutters, door, and porch. Glue these on with cellulose cement or waterproof casein or resin glue. Give the front several coats of well-thinned white enamel or paint. Use green enamel for the shutters and black for the window openings. Cement shingles to the front roof and stain them with green paint, well thinned with turpentine to form a stain.



Siding, shutters, and shingles are of thin wood, fastened to the pressed composition board with a waterproof cement

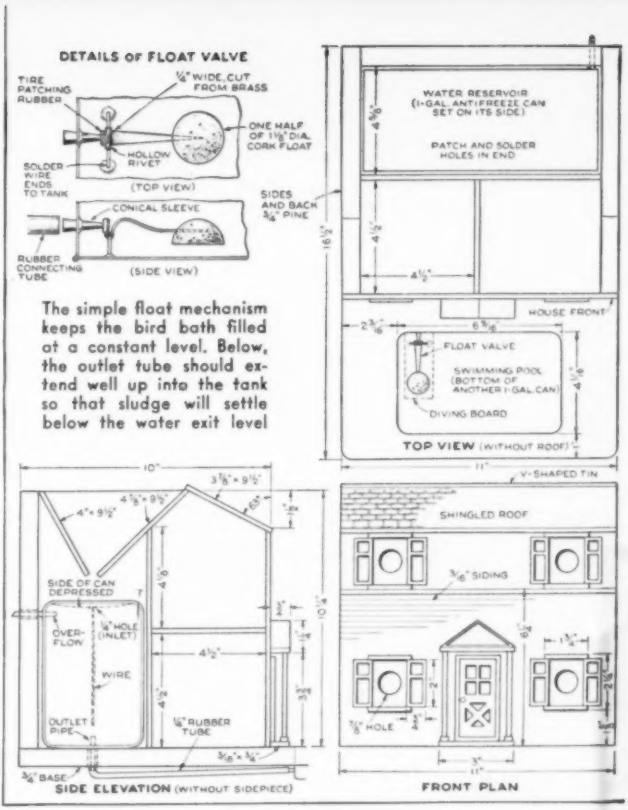
The bottom of a gallon can forms the bath. Fasten with a few brads near the top edge

Cut an opening at one end of the ¾" by 11" by 16½" pine baseboard to receive the bottom part of an empty 1-gal. can, which forms the bath. Solder the conical metal sleeve from a cheap automatic pencil into the side of the pool, and make the float valve as shown in the drawing.

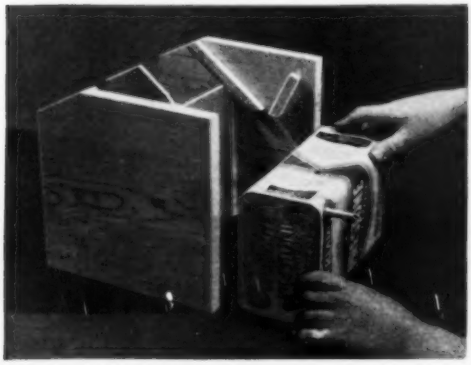
Sides and back of the house are cut from pine, with partitions of plywood or pressed composition wood. Another 1-gal. can is needed for the water reservoir. Depress one side of the can so that water will run into a ¼" hole at the center, and solder a heavy wire into the hole so that it reaches almost to the bottom. Water will follow the wire and thus run in without a dripping noise, which might disturb the birds.

Overflow and outlet pipes are of ¼" copper or brass tubing. Connect the outlet to the pool with rubber tubing so that the reservoir may be removed for flushing each season. The outlet pipe should extend up into the container so that the sludge will settle at the bottom.

Be sure to paint the completed bird house to make it waterproof, and coat the inside of the pool with asphalt varnish. If desired, a model springboard may be installed above the float valve to keep the birds from interfering with its action.



The simple float mechanism keeps the bird bath filled at a constant level. Below, the outlet tube should extend well up into the tank so that sludge will settle below the water exit level



The reservoir is an antifreeze can, with an overflow pipe through which excess water may run off

Partitions of plywood or composition board divide the house into four rooms. Sides and back are pine

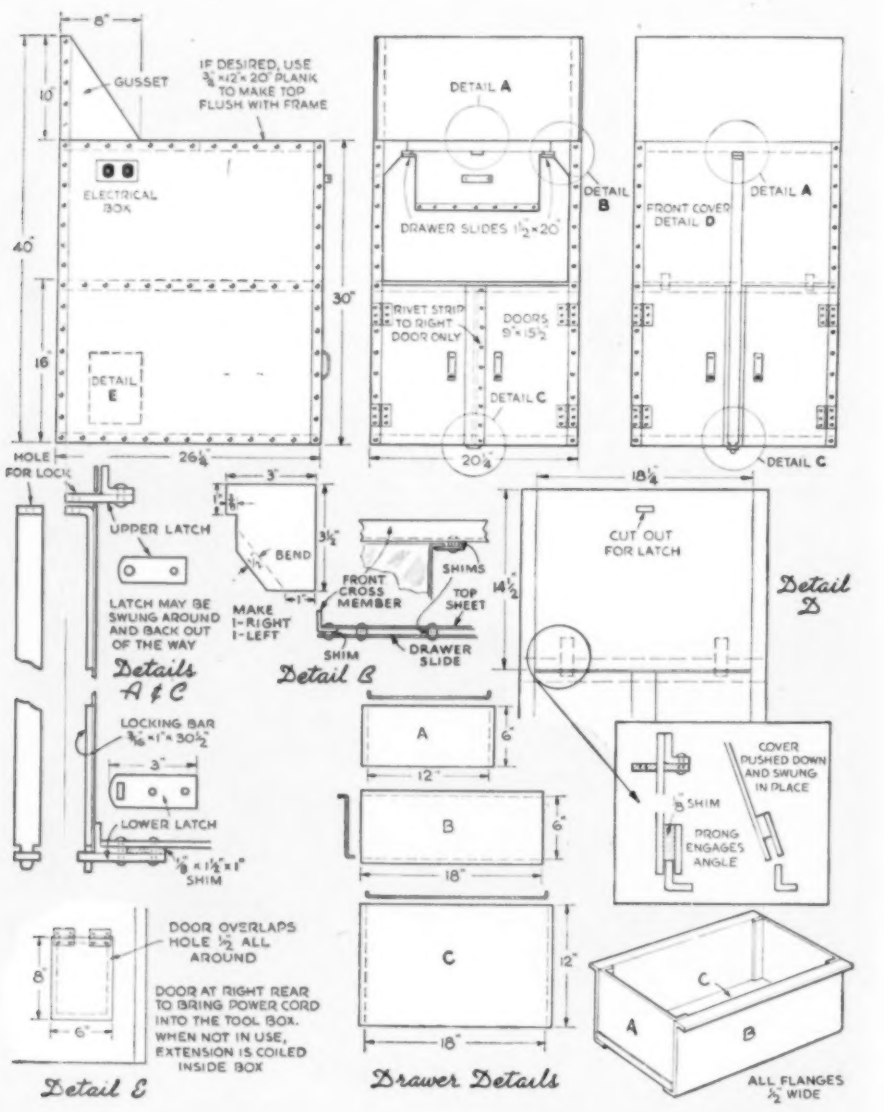
AIRCRAFT MECHANIC'S
Rolling Tool Box

By PETER KLEIN, JR.

AIRCRAFT mechanics and others whose work requires a large kit of expensive assembly tools will find it worth while to construct a rolling tool box of the type illustrated. This resembles a small safe and serves as a portable workbench and tool cabinet. The materials will cost about six dollars at a local sheet-metal supply shop.

When the materials listed have been obtained, square off the vertical corner members and trim one side of the horizontal members to a 45-deg. angle at each end so that they will meet at a right angle; then fit them together into a skeleton framework. Bolt with No. 5 machine screws in No. 30 (⅛") holes. Lay out the remaining holes approximately 2" apart.

Fit the sheets into the framework and bolt in several places, removing the pre-



viously placed screws one at a time as necessary. Then drill the remaining holes and rivet the sheets, finally replacing the screws with rivets also.

To rivet, a bucking bar and a rivet set are required. The rivet set may be made by grinding the point of a drill, of the same diameter as the heads of the rivets to be used, to the approximate shape of the rivet heads. With this, drill the end of a short steel rod to form a cup into which the rivet head will fit. As the set is hammered on the rivet, which is firmly held or bucked up on the other side with the bucking bar, it will shape the tail of the rivet into a neat button. For those who prefer to dispense with riveting, No. 8 roundhead machine screws ⅜" long may be substituted in No. 18 (5/32") holes. To prevent the screws from loosening, peen the ends of the screws over the nuts, or center punch the nut and screw. Fit and rivet the bottom sheet, then the center piece, and finally the top.

Fabricate the drawer according to the drawings. For the necessary bends, a metal brake may be used, or the metal may be clamped between two pieces of angle iron and hammered over with a block of wood.

The drawer supports are bolted to the top with shims between to allow clearance for the drawer to slide freely. Attach handles and door hinges, and make the bar and latches for locking the box as shown in the sketches. If electric tools are to be used, the box may be wired with an outlet, and a long extension used to connect with the main power supply.

To permit the cabinet to be rolled about, either four steel casters or a combination of two small carriage wheels and two casters are attached, depending on the condition of the shop floor.

A machinist's tool box can be mounted on top of the cabinet. The tool cabinet illustrated has now been in use for several months in an aircraft shop.

MATERIAL LIST

0.040" SHEET STEEL

3 pc. 1½" by 20" for drawer slides and door overlap
3 pc. 20" by 26" for top, middle, and bottom
1 pc. 14½" by 18¼" for top front cover
2 pc. 9" by 15½" for doors

0.028" SHEET STEEL

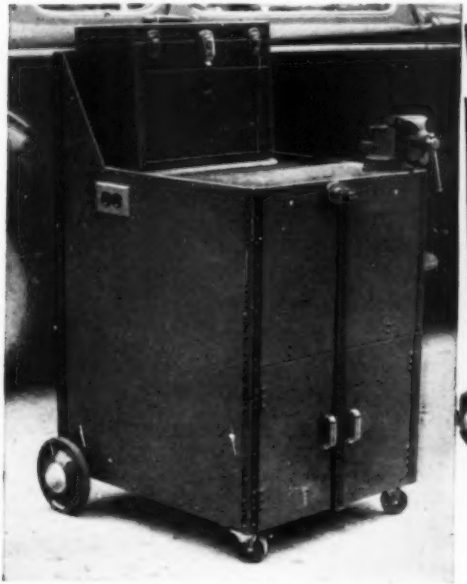
1 pc. 20" by 40" for back
2 pc. 26" by 30" for sides
1 pc. 12" by 24" for gussets
1 pc. 12" by 19" for drawer bottom
2 pc. 6" by 13" for drawer front and back
2 pc. 7" by 18" for drawer sides

⅛" BY 1" BY 1" ANGLE IRON

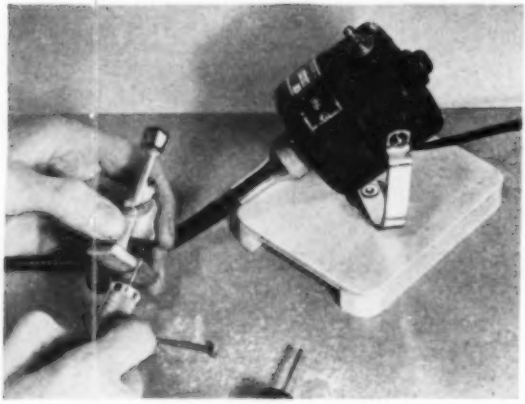
2 pc. 30" long for front vertical members
2 pc. 40" long for rear vertical members
6 pc. 26¼" long for side horizontal members
6 pc. 20¼" long for front and back horizontal members

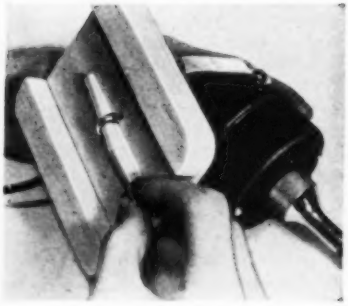
MISCELLANEOUS

1 pc. strap iron 3/16" by 1" by 39" long for locking bar and latches
5 doz. No. 5 machine screws ¾" long with nuts
2 doz. No. 10 machine screws ⅝" long with nuts
1 lb. ⅛" roundhead rivets (iron) ⅝" long
3 drawer handles
6 small hinges
4 steel-wheeled casters, or 2 casters and 2 small carriage wheels with axle



Easily rolled from place to place, this compact cabinet is virtually a mobile workshop, yet it can be securely locked to safeguard costly tools

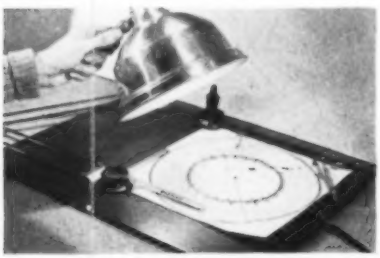




A flexible-shaft tool becomes portable when mounted upon this base, yet it can be instantly detached. The base may be clamped to a table or bench

Base Increases Working Range of Flexible-Shaft Tool

THE simple base illustrated makes any flexible shaft tool independent of its wall support. Fasten two $\frac{1}{2}$" by $\frac{3}{4}$" feet to a piece of 3/16" plywood, slot the latter in the center, insert the motor-bracket ring, and lock it with a small hardwood wedge. A washer between bracket and base allows the motor to swivel.—RICHARD HANSCOM.



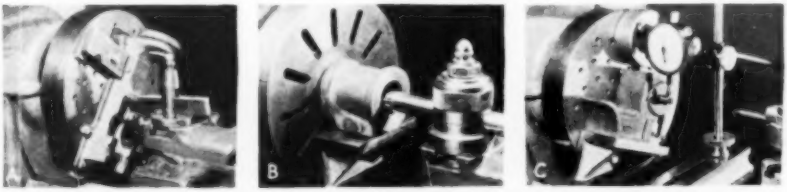
Heat Lamp Dries Drawing Ink Quickly in Humid Weather

A SMALL therapeutic or "heat" lamp is a valuable aid to the draftsman in drying ink on drawings in damp weather. Hold the lamp a few inches away, and blow gently across the wet ink. Even on humid days the ink will dry in a matter of seconds. This simple trick may save much valuable time when a succession of lines has to be drawn in a hurry.—WALTER E. BURTON.

FACEPLATES

[LATHE WORK—11]

Many pieces that cannot be held between centers or in a chuck can be fastened to a faceplate by means of bolts engaged in slots or tapped holes as at *A*. Work to be bored may be mounted with an angle plate as at *B*. Precision work may be accurately located with one or more toolmaker's buttons and a dial indicator as at *C*. If work tends to shift under heavy cuts, place a sheet of paper between it and the faceplate. To eliminate vibration when work is mounted off center, bolt on a counterbalancing weight.



Three typical set-ups for mounting irregularly shaped work on the faceplate of a lathe

POPULAR SCIENCE MONTHLY SHOP DATA FILE

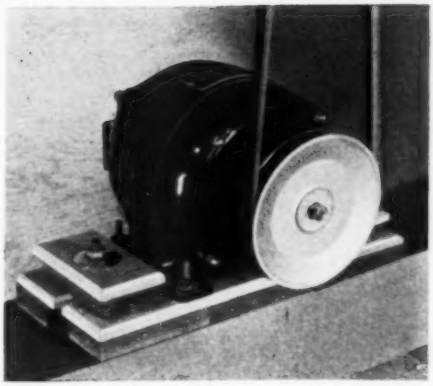
Leaky Blowtorch Plug Sealed with Application of Soap

PERSISTENT leaking around the filler plug of a blowtorch can be stopped by applying soap generously to both the threads and seating surface. The plug may then be screwed in by hand and should require no excessive tightening.—HOWARD R. HEYDORF.

Soap will remedy a worn blowtorch filler plug. It pays, in fact, to treat a new plug with it

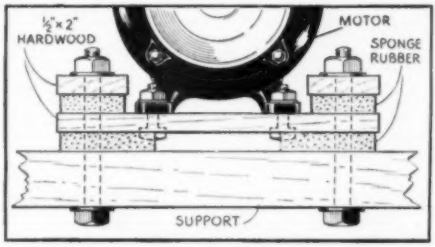
Quick Way to Widen a Crack

WHEN a crack in a heavy casting has to be welded or brazed, the work of chipping it V-shaped can be made easier by first drilling a line of shallow holes along it with a sharp, lightly fed drill.—EDGAR WALKER.



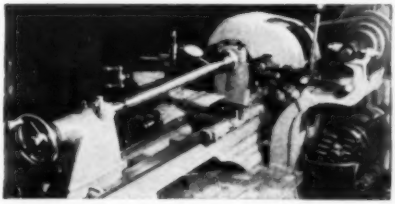
Vibrationless Motor Mount

THIS rubber-cushioned motor mount is exceptionally free from vibration, and makes a quiet-running unit. The motor is entirely insulated from its support. Use double sponge-rubber insulation between the mounting bolts, as shown.—R. O. LISSAMAN.



ALIGNING LATHE CENTERS [LATHE WORK—12]

If lathe work held between headstock and tailstock centers is to be accurate, the centers themselves must be accurately aligned. They may be checked by means of a test bar and dial indicator as shown. The steel bar—in this case 1" in diameter—is center-drilled, mounted between centers, and turned to exactly 7/8" for a short distance at each end. Mount the indicator in the tool post and adjust it to read zero with the plunger resting against one of the turned portions. Without changing the setting of the cross slide, move the indicator to the other end of the bar. If the reading is zero, the centers are in line. If not, loosen the tailstock clamp and set the tailstock center over by means of the adjusting screws.



POPULAR SCIENCE MONTHLY SHOP DATA FILE

Mirror Making

THE SECRET OF SUCCESS LIES IN CLEANING THE GLASS PROPERLY

By WILLIAM H. SHIPPEE

Surface dirt is removed by scouring the dry glass with powdered pumice in a cloth bag. Four wedges facilitate lifting the sheet by its undersurface

THERE is more to mirror making than pouring a silvering solution over glass. The secret of success lies in preparing the glass so that it will be physically and chemically clean. Even the pores in the glass surface—and glass does have pores—must be cleaned of every particle of dirt and grease in order that the silver will properly deposit in them.

Most work requires a preliminary cleaning with nitric acid, or with what is known as a caustic "base," such as caustic soda or caustic potash. When this has been done, water should no longer "draw away" from any part of the glass surface. Pay special attention to the corners, which are apt to be dirtier and more likely to be neglected than any other part of the surface.

After the glass has been cleaned with the acid or base, it must be dried *thoroughly*, then rubbed with pumice stone. If the surface it wet, the pumice stone will scratch. The best way to use pumice stone is to put some in a finely woven sack and rub the surface with this. This will remove surface dirt, but will not reach into the pores.

Mark all brushes used in cleaning. Scrub briskly but with light pressure. Touch neither edges nor surface of the glass with the fingers at any time

For the next steps, mark four brushes with the numbers 1, 2, 3, and 4, to avoid confusing them. They can be of any size to fit the job, but they must be *clean*. Do not use pressure as it tends only to flatten out the brushes and cause them to scrub sidewise instead of into the pores of the glass.

First, use brush No. 1 and faucet water to cleanse the glass of pumice. Next, use brush No. 2 with a solution of stannous chloride, 1 oz. to 1 gal. or 7 g. to 1 liter. This improves the surface for silvering. After a vigorous scrubbing, wash the glass thoroughly with faucet water, using brush No. 2. Then rinse the glass again with faucet water, using brush No. 3 this time in order not to carry over any stannous chloride. Again be sure to give the corners special attention.

Finally, remove all traces of chemicals and faucet water with distilled water and brush No. 4. If at any spot the distilled water should draw away, the surface is unfit for silvering and the whole cleaning process must be repeated. At no time should the fingers be allowed to touch the surface to be silvered, or even the edges of the glass. If the glass cannot be handled without touching the upper surface, rubber gloves must be worn.

Now level the glass with small wooden wedges, so that water will not run off, but will stay "heaped up" evenly over the entire surface. No pan is needed for the cleaning or silvering except to catch the

run-off and thus to measure approximately the amount of water surface tension will keep on the glass, so that the proper amount of silvering solution may be made up.

Four solutions are necessary for the actual silvering. They are:

Silver nitrate	1 oz./pint or 20 g./300 cc.
Potassium hydroxide	5 oz./quart or 14 g./100 cc.
Ammonium hydroxide	concentrated (28 percent)

A reducing solution consisting of:

Distilled water	1 quart or 1 liter
Table sugar (sucrose)	3 oz. or 90 g.
Nitric acid (concentrated)	1 dram or 4 cc.
Alcohol (ethyl 95 percent)	6 oz. or 175 cc.

All chemicals must be what is known as the "c. p. grade." The silver nitrate solution must be kept in a brown bottle away from the light. The reducing solution should be several days old, when used, and improves with age.

The solutions are used in the ratio of silver nitrate 15, potassium hydroxide 5, reducing solution 6, the total quantity slightly in excess of the amount of distilled water that will stay "heaped up" on the cleaned glass. Mix the solution as follows:

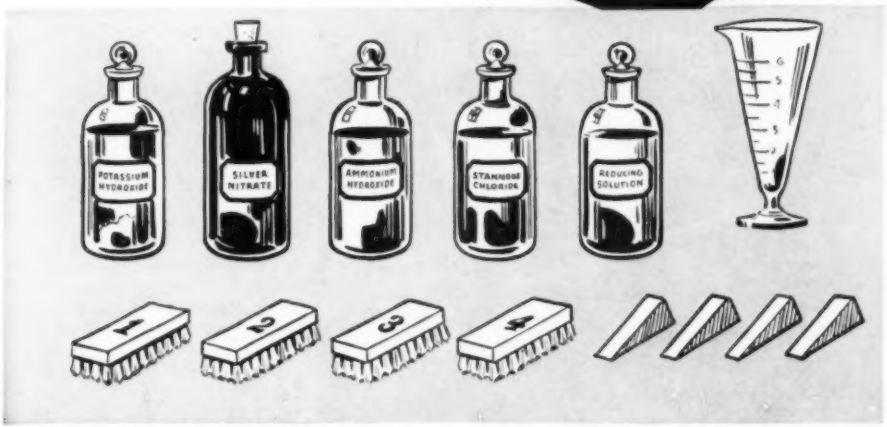
Pour the silver nitrate solution into a *clean* beaker, and add ammonia with an eye dropper. The first drop of ammonia turns the solution dark. Keep adding the ammonia cautiously until the solution just clears; do not go further beyond this point than can be helped. Now add silver nitrate solution until the liquid is slightly straw colored. Then add the potassium hydroxide solution, which turns the mixture dark again. Add ammonia, again with an eye dropper, until the solution does not quite clear. If it does clear completely, add silver nitrate solution until the straw color again appears.

Have the correct amount of reducing solution ready. Pour off the distilled water, which has been left on the glass meanwhile to prevent contamination; add the reducing solution to the first solution and pour on the surface to be silvered *immediately*. After from six to ten minutes pour the solution off the glass and clean off the sediment carefully with cotton (or a clean chamois) and distilled water. If a bright light shows through readily, the coat is too thin and another should be applied at once. Cover the mirror with distilled water while preparing the second solution. Finally, *DO NOT* allow any mixed solutions to stand. Highly explosive and dangerous silver fulminate is formed.

After the mirror is completely dry, apply an air-tight and moistureproof backing. A bronzing paint made of finely powdered metal and lacquer is very good. The minute particles of metal overlap each other.

Don't be discouraged if your first mirror does not turn out well. Your second should be better, and it is only by experience that the technique can be developed to perfection.

Distilled water should spread uniformly over the clean glass. If it draws away anywhere, recleaning is required



All chemicals for mirror making should be chemically pure (c.p. grade). Store silver nitrate in the dark

Cruising Sailboat

PART III: PUTTING THE PLANKS ON "WHITECAP"

By Bruce and Willard Crandall

Fastening the garboard plank in place with clamps for a fitting

PLANKING makes the hull of a boat. Properly fitted and fastened, it keeps the water where it belongs after the boat is launched—outside. For that reason, careful workmanship at this point in the construction of the 19′ *Whitecap* will go far toward assuring the utmost pleasure and satisfaction when the finished boat takes the water.

It will simplify the work of plank fitting if the battens are put in as the planks are fitted, rather than all at once. After each plank is fitted, mark along its edge on the frames for the center line of the next batten. Cut batten notches in the transom framework, but not in the transom

"Whitecap's" design is such that comparatively little time is required for shaping and fitting planks. No difficult bending or spiling is necessary, which makes construction easier for inexperienced workers

planking. Fasten the battens with 1½" No. 8 screws.

Before the planking is started, notches should be cut in each frame, next to the keelson, to form limber holes. The bilge water can then run from one part of the boat to another, which will facilitate bailing.

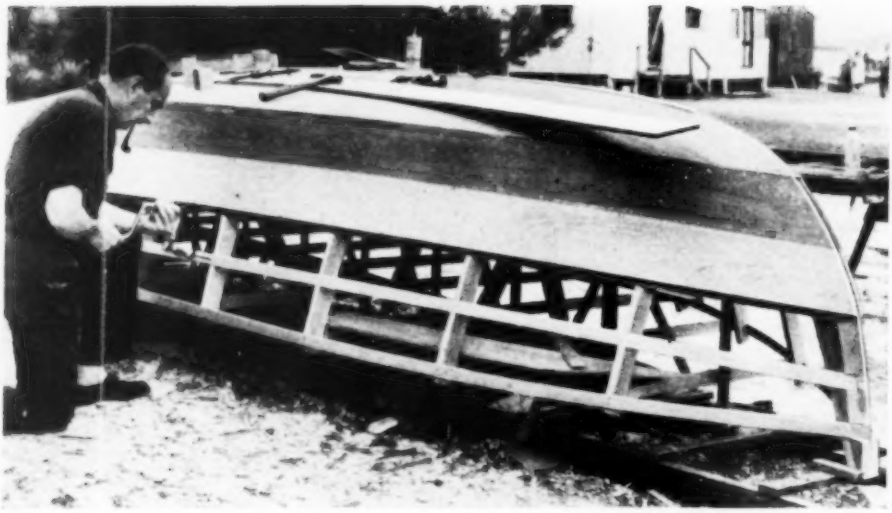
Start the planking with the garboard planks—the bottom planks next to the keel. To fit a plank, first clamp it in position, without forcing it edgewise, and mark along the edge to be fitted with a pencil compass. The plank is then cut and planed to shape, and clamped in position again for the final fitting. The garboard planks are made from 6" (5½" finished lumber) by 18' boards; next, on each side, two 4" by 18' boards are used, then a 6" by 18' board, two 6" by 16' boards and finally an 8" width, which finishes the bottom. All the 20' lengths are for side planking.

The planks below the water line should be left at least 1/16" apart to allow for swelling. This will not cause any leaking. If the seams do not swell shut after the boat has been in the water for several days, they may be filled with cotton wicking covered with seam composition.

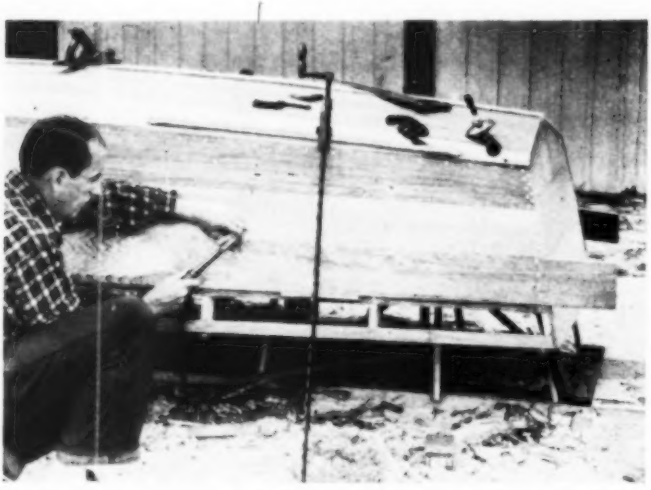
After the first three planks on each side of the keel are in place, put on the bottom side planks and fit them to the forward ends of these bottom planks. Then the side planks should be dressed down flush with the chines; the remaining bottom planks will merely lap over them.

Just before fastening each plank, coat with marine glue the battens, transom, transom frame, stem, keelson, chines, and all joints that need to be waterproof. Then lay a strip of cotton flannelette over the glued joint and coat the cloth with the glue. The cloth may be entirely eliminated except for the joint between the inside and outside stem, and marine glue only used, if you are sure that all adjoining surfaces are a perfect fit. When fastening a plank, first clamp it in place and then drill holes for the screws. A countersink attachment on the drill itself will save a lot of work and insure the drilling of all holes to the right depth. The screws should be countersunk enough so they can be covered later with marine putty or plastic composition.

Screw the planks down with flathead screws as follows: (1) Into transom and transom frames, a double row of 1½" No. 8, spaced about 1" apart; (2) into stem, 1½" No. 8, spaced 1" apart; (3) into frames, 2" No. 10, spaced 2" apart; (4) into keelson and chines, 1¼" No. 8 spaced 1½" to 2" apart. The planks can be fastened to the battens with 1¼" galvanized nails clinched,



Here a seam batten is being fastened to the frames before the addition of the third plank to the side



For the sake of appearance all side planks should be tapered slightly toward the stern. By using long boards the necessity of plank splicing is avoided

or with copper rivets, or ¾" No. 7 or No. 8 screws spaced not over 2" apart. Holes should be drilled for the nails unless wood soft enough to prevent splitting is used for the planking and battens. If screws are used, it is best to select oak or some other hard wood for the battens.

It will improve the looks of the planking if all of the side planks are tapered toward the stern so that they are all the same width at the transom. The side planking is pu on in the same manner as the bottom, using a 10" width for the sheer plank and 8" width for the other three.

Marine plywood ⅜" thick may be used for planking instead of the batten-seam construction, and may also be used for the transom and coaming. All the battens will then be eliminated, but the plywood will have to be spliced on bottom and sides. A butt block of ⅜" plywood, coated with resin glue, should be used behind each splice. Each side can be planked with two 10′ lengths, making the splices come between stations 5 and 6. On the bottom 8′ and 10′ lengths will bring the splices between stations 6 and 7 or between 4 and 5. It will be easiest not to use a rabbeted stem with plywood planking. A more complicated type of chine, as illustrated in one of the drawings, is preferable because it will protect the edges of the plywood.

After the planking is completed, the planks at the stem are dressed down to fit the shape of the outside stem, unless a rab-

A steam-bent outside stem saves time by eliminating rabbeting and shaping the plank ends to fit into the rabbet

Hot from the steam box, the outside stem is bent and fastened in place. Plenty of helpers will be useful in doing this job

beted stem has been used. The outside stem should be cut to shape and soaked in water for several days before steaming. An ordinary teakettle connected by a rubber hose to a length of galvanized drainpipe will make a good enough steam box. Unless you have plenty of helpers, it may be best to bend the stem on a form and let it dry before an attempt is made to fasten it to the boat.

The outside stem is fastened to the inside stem with 3" No. 12 screws and planed down smooth with the planking, leaving a flat surface large enough to attach the $\frac{5}{8}$" half-oval stem band. The skeg and sternpost can now be added. They are fastened securely from inside as well as outside with $2\frac{1}{2}$" and 3" No. 12 screws.

(To Be Continued)

"Whitecap's" hull as it looks with the planking completed and the deck beams and carlings installed

FOUR NEW GAMES TO PLAY ON OUR

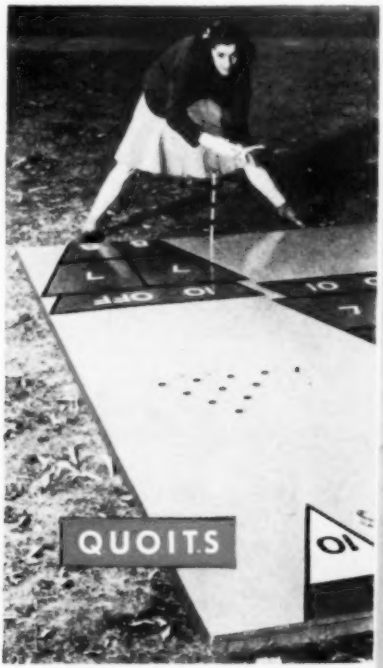
Fun-for-all Court

By Charles and Bertram Brownold

VERY little additional equipment is needed to adapt the POPULAR SCIENCE portable game court (see P.S.M., Apr. '41, p. 150) for playing four more games —tenpins, disk croquet, twelve-hole, and quoits. The accessories for these games are:

Tenpins. These may be bought for so little that it is hardly worth while to turn them, although those who enjoy wood turning may want to make their

The game court has many uses, as shown here. Possibly your ingenuity will develop others



own. About a foot high is a suitable size.

Balls. Wooden balls come with the tenpin set, if one is purchased, but solid rubber balls will do. A good size is 2″ in diameter.

Wickets. These are 7″ wide and 7″ long. When placed in holes drilled to receive them and pushed through to the ground, they have 4¼″ clearance. Wickets with square corners are easier to bend than arches.

Mallets. The heads of the mallets can be turned or sawed from a cylindrical pole. The edges are rounded to prevent splintering. The handles are ¾″ dowel sticks thrust into holes bored in the heads. A saw cut is made in the end of the stick and a hardwood wedge inserted for spreading the end of the handle in the head. The mallets are banded with different colors of paint in the same way as the shuffleboard cues, and for the same reason.

Stakes. These are about ⅝″ in diameter and 18″ long and are decorated with bands of bright-colored paint so they can easily be seen.

Twelve-hole board. The diameter of the holes must be slightly less than that of the balls so that the balls will drop into the holes but not fall through. If the holes are cut with a hand coping saw, the board must be made in four panels so the blade can reach the holes. The panels are cleated together on the underside, and a fence of brass 2″ wide fastened around the curved end of the board and along both sides. The position of the holes and cleats is shown in the drawing.

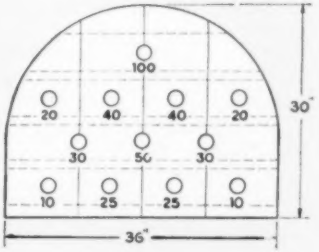
Quoits. These may be bought at five-and-ten stores or toy stores. Or if there is some scrap rope lying around, 20″ of it will make a ring about 6″ in diameter. Before cutting the rope, wrap a few turns of adhesive tape about it on either side of where it is to be cut. This will prevent unlaying. The two ends can then be joined with wide adhesive tape.

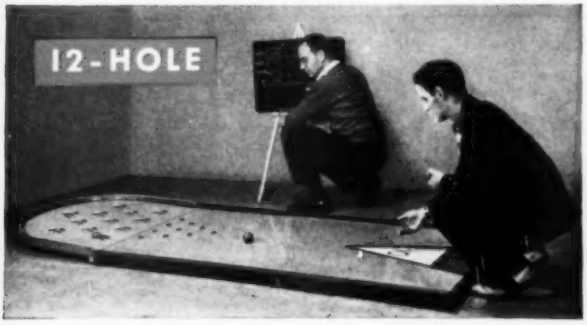
If it is decided to paint the target mentioned in the preceding installment, instead of buying one, draw five concentric circles with string and chalk on the inside of one of the sections of the game court. The numbers are painted on—black numbers on white rings, and white numbers on black rings.

A feature of the game court is the problem it offers in working out additional games to be played upon it. These may be well-known games, or games that you invent. Don't let the markings necessary for one game interfere with those needed for any other. Auxiliary equipment can be designed and made for games that require accessories other than the ones described.

Quoits, left, may be played with the full court, or for a short toss, with two panels

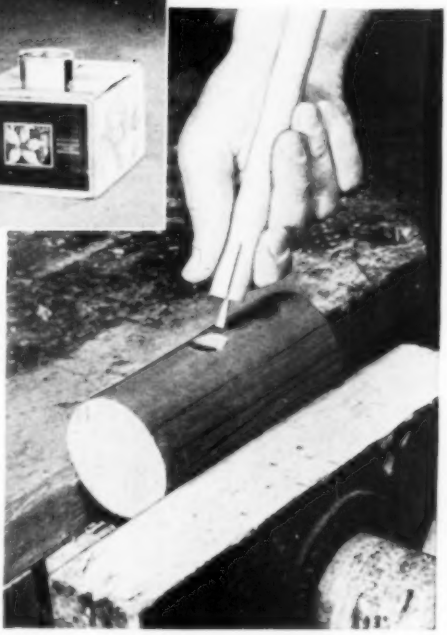
The twelve-hole board is laid out and marked as shown at right. Below, the board and a panel of the court as used for the game





The sharpened upper end of a nail driven into a box corner makes a good spindle for painting colored rings on the handles of croquet mallets

A dart target can be drawn with string and chalk, and finished with black paint



Croquet mallets may be turned or cut from round poles. Hardwood wedges driven into saw cuts in the ends of the handles fasten them in place

Following are the rules for the four new games referred at the beginning of this installment:

DISK CROQUET

This game can be played by teams or single players. The object is to propel the disks with mallets through the wickets as indicated approximately by the arrows in the diagram on the opposite page. Use shuffleboard disks for this.

The first player places his disk midway between the home stake and the first wicket. For each wicket through which he shoots his disk, he is allowed another stroke. Thus, if he drives through the first two wickets in one shot, he may have two more shots toward the next wicket. His turn ends when he fails to go through a wicket.

If a player strikes another disk with his own, he may either "croquet" the other disk or have a free shot. But if his disk comes to rest touching another disk, he must croquet it. The disk he hits is dead, and he cannot strike it again until he has first passed through the next wicket.

To croquet a disk, place both so that they touch, rest your foot on your own to hold it firmly, and strike it with the mallet.

When a player completes the course, he may hit the final stake and retire from the game, or refrain from hitting the stake and become a "rover." A rover plays in his turn and helps his partner and hinders his opponents. The winning side is the one that first completes the course, both partners hitting the home stake.

TWELVE-HOLE

This is played with the twelve-hole board, one section of the court, and two of the sidepieces. The object is to roll the balls into the holes.

Each player rolls three balls per inning,

and there are seven innings. At the end of each player's turn, the numbers under the holes are added and scored. Players should roll the balls, not throw them, and should not step upon the court while playing, or rest their hands on it.

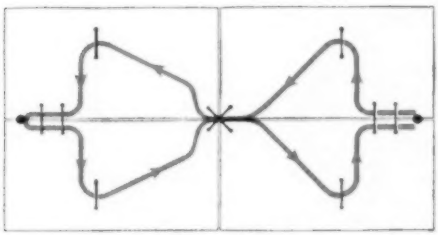
QUOITS

The game is played with all four sections of the court, and the stakes are set up as in disk croquet. The object is to toss the quoits over the stakes from the opposite ends of the court. For a shorter toss, use only two sections of the court. Players take positions at opposite ends of the court. After one player has tossed the quoits at the stake at the far end, the next player tosses them back to the other stake from his end. Scoring is as follows:

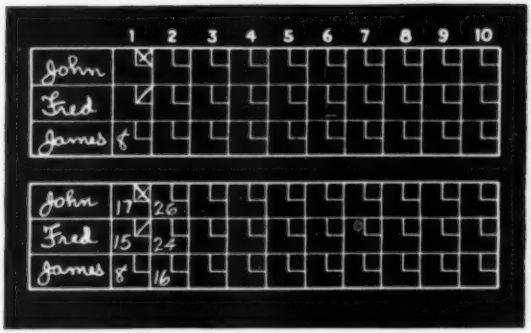
Ringers (quoits that ring the stake)	10 points
Leaners (quoits that lean against the stake)	5 points
Touchers (quoits that touch the stake)	3 points

Play is for a predetermined total.

Croquet wickets cut from heavy wire are easier to bend if square corners are used instead of arches



This is the proper course to follow through the wickets when using your portable game court for disk croquet. Start and finish at the same stake



For scoring tenpins, draw ten boxes for each player, with another box in the upper right corner of each. A diagonal line indicates a spare, and a strike is noted with a cross

TENPINS

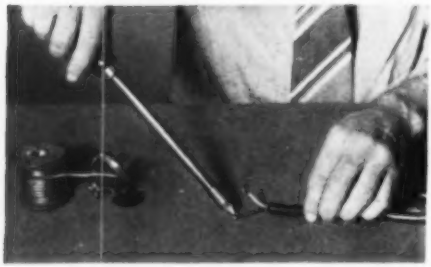
All sections of the game court are used. If the sidepieces are attached, they should be depressed so that there are no rims. The sections are arranged with the section having the ten spots for the pins at one end, and the triangle formed by the spots pointing toward the other end. The pins are set up on the spots, and the object is to knock them down by rolling balls at them from the other end of the court. Each turn of three balls is called a "frame." Ten frames are a "string."

If a player uses all three balls, he is credited with a point for each pin knocked down. If a player knocks down all the pins with the first two balls, it is known as a "spare." He does not use the third ball, but he is credited with ten points; and what he makes on the *first* ball of the next frame counts double. If he knocks down ten pins with his first ball (a "strike"), he does not use the other two, but he is credited with ten points; and all he makes on the first two balls of the next frame counts double.

A simple way to score is to rule off ten boxes for each player, with a smaller box in the upper right corner of each. Spares are indicated by a diagonal line in the small box, and strikes by a cross. Suppose, in the first frame, John strikes, Fred spares, and James knocks down eight. The score would then be as shown in the upper half of the illustrated score board. If, in the next frame, John knocked down seven with the first two balls and two with his third; Fred got five with the first ball and four with the other two, and James got eight with all three balls, the score would then be as shown in the lower part of the illustration.

"Deadwood," that is, pins that have been knocked down, should be removed from the court after each ball has been rolled.

Terminal Loops Formed on Flexible Wires by Using Solder

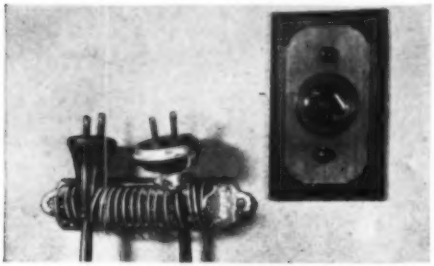


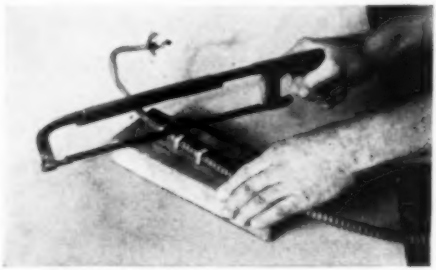
After the bared ends of the wires are formed into loops, solder is flowed over the twisted strands

STRANDED wires such as those in flexible cords may be connected to terminal screws neatly and securely by the use of solder. Trim the wires in the usual manner, bare the ends, and form these into a loop as shown. Solder is applied with a hot iron to weld the wires into a single, solid conductor at the loops. Place the loops around the screws so the strands turn to the right; then tightening the screws will tend also to tighten the loops. In wiring a plug cap, carry the wires around each prong to eliminate direct strain on the screws in case the cord is ever pulled violently.—H. P. S.

Old Rubber-Stamp Holder Acts as Rack for Cord Plugs

AN EXCELLENT plug holder for an overworked power outlet in the workshop can be made from an old rubber-stamp holder of the type illustrated below. With this device, the plugs are always at hand when wanted, and are less likely to get broken.—R. L.





Block Holds BX for Sawing

ENDS of flexible armored cable or BX are hard to hold while being trimmed with a hack saw, but a device to aid in gripping them can be made as shown above by driving three BX staples into a 12" length of two-by-four. A piece of rubber stair tread tacked to the bottom of the block keeps it from slipping on the bench.—C. L. S.

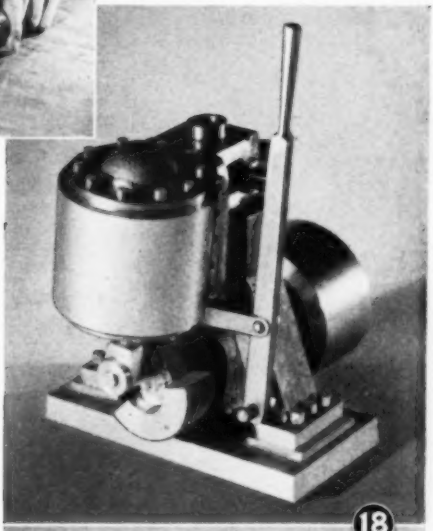
ELECTROPLATING, PART 2 [*ELECTRICAL*]

The *electrolyte*, often called the *solution* or *bath*, is a conducting medium that supports the passage of an electric current from the anode, or plating metal, to the work, or article to be plated. To the solution of salts of the metal to be plated are added other chemicals so that the electrolyte will (a) conduct current readily; (b) dissolve from the anode approximately the same amount of metal deposited at the cathode, doing so evenly and in sufficient quantity; (c) remain in good working order over an extended period of time.

A solution should not be used at a temperature below 65 or 70 deg. F., and some of them must be much warmer. Except in the case of recessed work (having deep holes or cavities that must also be plated), it is an advantage to agitate the bath frequently. Water must be added to replace any lost by evaporation; an electrolyte that becomes too concentrated, as well as one that is too dilute, will not deposit a satisfactory film of metal. Purity and cleanliness are important, so protect electrolytes from dust. Filter or replace any solution that is not clean and clear.

This small working model is a fascinating, instructive project for beginner and expert alike

Two views of the finished engine. The unusually compact design and reverse gear render it ideal for power ship models. A single long lever affords finger-tip control



OSCILLATING STEAM ENGINE

with Reverse Gear

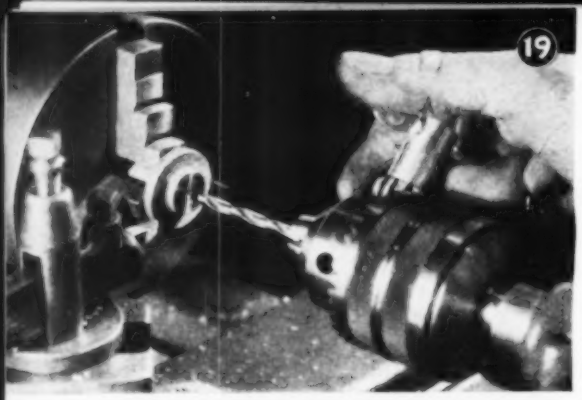
PART II

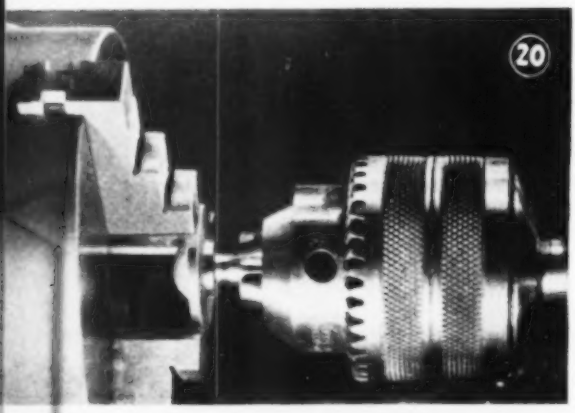
By C. W. WOODSON

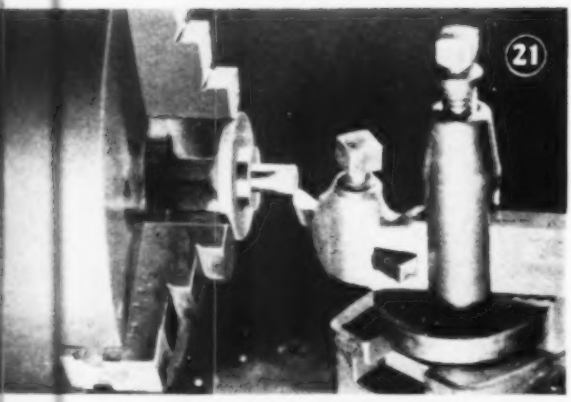
IN CONSTRUCTING our small oscillating steam engine with reverse gear, the next problem is chucking the cylinder head to run true. This may be done as shown in Fig. 20. It is held by the chucking lug in a tailstock chuck while the scroll-chuck jaws are tightened down. In Fig. 21 the lug is being turned true and the work on the bottom side completed. The casting is held in a collet as in Fig. 22 while the top and outer edge are being machined, after which the chucking lug can be cut off.

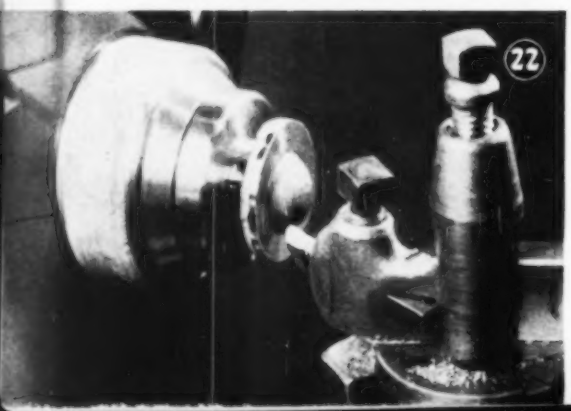
The lower cylinder cover or piston rod guide is shown in Fig. 19 being machined in much the same way. The piston-rod hole is drilled at this time, which will center the piston rod accurately. The three vent holes shown in the drawings are then drilled, as well as the screw holes for fastening to the cylinder.

The piston casting can be held in a chuck or collet by the lug provided for this purpose, as in Fig. 25, and machined all over,









including the hole for the piston rod, at this same setting. The piston should be turned to a nice fit in the cylinder bore, free enough to slide, but without shake. The piston groove can be packed with soft, well-oiled string. Don't cut and thread the piston rod until the engine is assembled because the length may vary slightly from that given in the drawings.

The flywheel should be machined carefully to insure its running dead true. If the rough casting is out of round, it can be turned to run fairly true when chucked as in Fig. 26. Here all of the work should be done on this one end, including the drilling and reaming of the shaft hole. The casting may be reversed in the chuck and the other end rough-turned to shape, but for the last finishing cuts it will be best to mount it between centers on a mandrel as shown in Fig. 27. Finished in this way, it will run true when finally mounted upon the crankshaft. The drawings of the flywheel show a method of fastening it in place by drilling and tapping a hole partly in the flywheel and partly in the shaft, and inserting a screw to act as a key.

The reverse lever is made up from a piece of cold-rolled steel 3/16" thick by ¼" wide. This is chucked as in Fig. 28 and the tapered handle turned to shape. The lever is then finished by filing to the dimensions given in the drawings. The two links are made of sheet brass and lightly riveted to the lever.

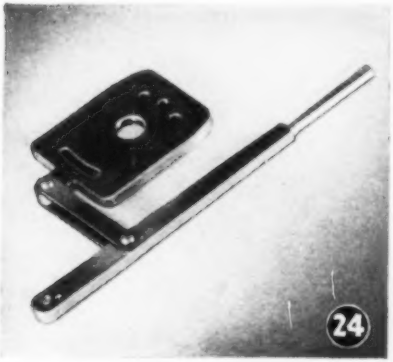
The reverse plate, Fig. 24, which is perhaps the fussiest part of the whole job, is made up from ⅛" brass cut to the dimensions in the drawings. The three shaded holes are steam ports and are in the same radius as the steam

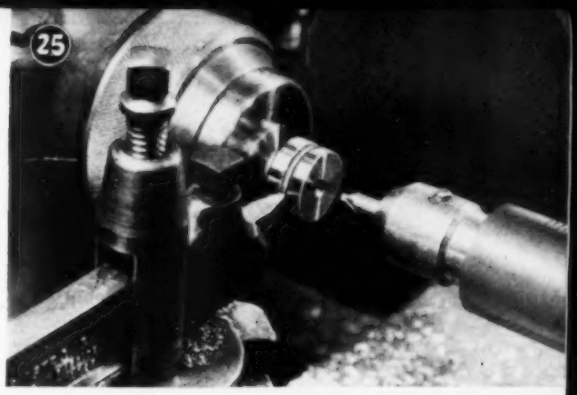
port in the cylinder. The unshaded holes are drilled halfway through and are connected to the ports as shown in the drawings by routing or cutting the metal away with a fine chisel. A slot is cut in the lower part of the plate to ride over a pin in the frame, which acts as a stop to center the plate over the ports when the engine is reversed.

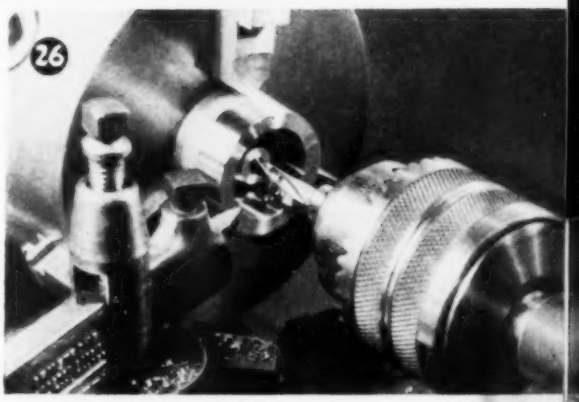
The three sketches in the previous installment show how the ports are laid out on the brass reverse plate. The pivot point is first located, and the three radius lines scribed with dividers. The ports are next laid out, and the three shown shaded are drilled clear through. The others are 1/16" deep or only halfway through. This allows the steam to enter the center port while the engine is running in either direction, and the exhaust to leave one or the other outer ports according to which way the engine is running.

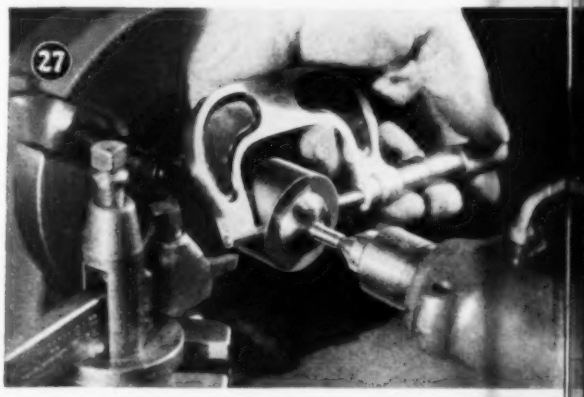
Finish the reverse plate as smoothly as possible on a lap. Care in finishing the port faces will reward the builder with a smooth-running engine.

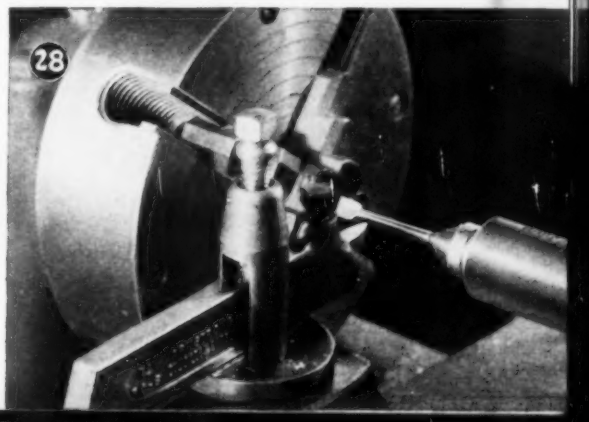
When the rocker shaft has been made and a suitable spring obtained, the engine can be assembled. After putting a little tension on the pivot spring and oiling the moving parts well, try the engine on the shop air line or, if a small boiler is available, give the engine its initial tryout under steam. As the steam pressure has a tendency to force the port faces apart, the pivot spring will have to be adjusted according to the pressure used. If too loose, steam will escape, but if too tight, undue friction will cut down the speed. For this reason it is best to run the engine on not more than 25 lb. of steam.











Science Stunts

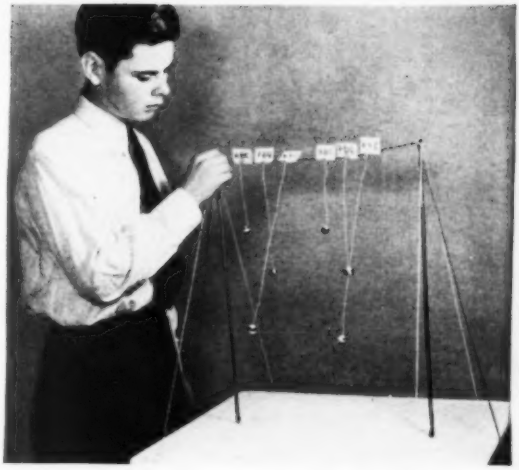
IF THE Wright brothers hadn't invented the airplane, someone else would have. Steam engines, automobiles, radios, were bound to come sooner or later. With all credit to their actual inventors, these things logically evolved as applications of nature's basic laws—which were deduced, in turn, through brilliant experiments and observations by science's pioneers. Simple demonstrations illustrated on these pages enable anyone to reënact a few of their history-making discoveries.

Even the fact that the earth rotates on its axis, while generally accepted, awaited positive proof until as late as 1851. It remained for the French physicist Foucault to hang a heavy weight by a 200-foot wire, from the dome of the Pantheon in Paris, and perform an experiment simple enough to be duplicated on a smaller scale at home.

PROVING THAT THE EARTH SPINS. First note that a freely swinging pendulum, as at left, maintains its direction even when you turn or move the supporting stick. Now rig up a long pendulum, shielded from air currents in a barn or loft, with 15 or 20 feet of wire and a weight of several pounds. Start it swinging, say, north and south. Within a few minutes, its direction apparently shifts—toward northeast and southwest, in the Northern Hemisphere. Actually the pendulum still follows its original course, while the earth and the floor of the building are turning beneath it! This becomes easier to picture in your mind, if you imagine the pendulum at the North Pole. With decreasing latitude, the effect slows down—and vanishes at the Equator, where all meridians are parallel.

ARTIFICIAL BUG WALKS ON WATER. How water bugs walk on the surface may be shown with the homemade model at right. A cork serves for its body, and thin wires for its legs. Its feet are of thin paraffined cardboard. Place the "bug" in water very carefully, so that all its feet touch at once, and their upper surfaces do not get wet. It will float, because of the curious phenomenon called surface tension. In a thin surface layer, that bends before it breaks, water molecules tend to cling together and support a foreign object.

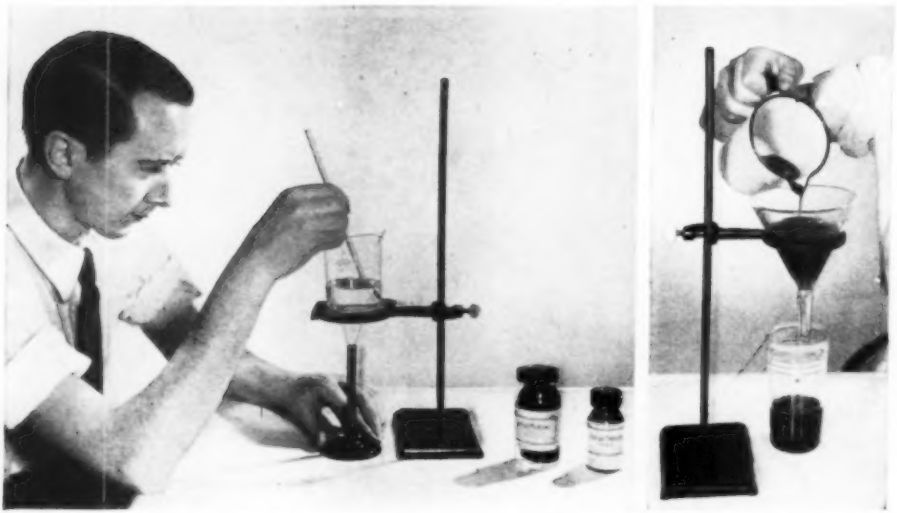
MODEL SIMULATES RADIO TUNING. From a horizontal cord, not too tightly stretched, suspend three marbles or other weights on cords of different lengths. Adjacent to these, hang a similar set of marbles on cords of matched lengths. Now start swinging a marble of the first set. The marble of the second set, with the same length of cord, will soon begin swinging in unison. The explanation is that each marble of the first set has a definite rate of swing, or vibration, to which the corresponding one of the second set responds. Likewise, a radio transmitter emits electromagnetic vibrations of a fixed frequency, which will evoke a response from a receiver tuned to the same rate.



HOMEMADE HYDROMETER. Often used for testing a car's battery, a hydrometer measures the specific gravity of a liquid—in other words, its weight compared with that of water. You can make an experimental one in half a minute, from an ordinary test tube weighted so that it will float upright. A slip of cardboard inserted in the tube will serve as a scale. Apply the numeral "1" at the depth to which the tube sinks in water. The tube will float higher in salt water, and lower in alcohol and various oils. Scale markings for these may be added by checking the homemade hydrometer against solutions and liquids of known specific gravity.

TUBE ILLUSTRATES BUOYANCY. Put enough water in a test tube so that it will barely float, and cover its end with a piece of rubber cut from a toy balloon. Invert the tube in a flask filled with water. Apply pressure with the palm of your hand to the mouth of the flask, and the tube mysteriously sinks to the bottom. It rises again when the pressure is removed. The water, virtually incompressible, transmits the pressure to the air in the tube and compresses it. This reduces the displacement of the tube and deprives it of its buoyancy.

Fun with Photochemistry



Left, dissolving ferric oxalate in water to make Kallitype sensitizing solution. Water must be heated just enough to dissolve the chemical. Right, filtering blueprint solution to avoid spotty prints

WHENEVER a camera clicks, or a photographic print is made, we witness an amazing feat of chemical magic, in which light is the magician. Exactly what happens when light strikes the silver salts of a photographic emulsion is not known. Usually, it leaves no visible trace nor apparent chemical change. Yet subsequent chemical treatment of the salts proves that they have been mysteriously transformed, and that light has left its indelible imprint. Scientific control of this magic is the basis of the whole great industry of still and motion pictures, and of photo-engraving, which makes possible the illustrations in newspapers and magazines.

The current photochemical theory of the latent image—the invisible, but *developable* image—left by light on photographic film or paper, is that a relatively small number of molecules in each grain of the silver salt is changed, or *reduced*, to metallic silver. Although the molecules are too small to be seen by even the most powerful microscopes, they form a sort of nucleus around which the whole grain is changed into metallic silver when treated with a developer. Salts of a number of other metals, including iron, are also affected by light.

Sensitive coatings of metallic salts, that demonstrate vividly this photochemical magic behind photography, may be made easily in the home laboratory.

Coatings on commercially made film and paper today are called emulsions, although they are really *suspensions* of finely divided silver bromide or chloride in a layer of gelatine. The gelatine not only holds the silver grains uniformly, but in some mysterious way adds to their sensitivity. Digesting, or heating the silver-gelatine mixture for a number of hours at a predetermined temperature, makes the emulsion still more sensitive.

Unless willing to equip himself for painstaking and expensive experimentation, the amateur had better avoid gelatine, and confine his efforts to paper sensitizers that utilize chemical salts alone.

The simplest of these utilizes iron instead of silver, and is standard for regular blueprint paper. It requires only two chemicals, and is developed, fixed, and washed with plain water! Dissolve 160 grains of brown ferric ammonium citrate in two ounces of water. In another two ounces of water dissolve 120 grains of potassium ferricyanide. If the ferricyanide is not perfectly fresh and clear, the crystals should be first washed in water and dried between blotters, to free them from powder. Mix the solutions and store in a dark place.

Almost any kind of smooth paper, except that made from wood pulp, may be coated, as may be close-woven firm cloth. The sensitizer is applied either by floating the paper on the surface of the solution for about three minutes, or by pinning down the paper and applying the solution with a wad of cotton or a rubber-bound camel's-hair brush, spreading it as evenly as possible. The coating may be done in any yellow light, and the paper hung up immediately in a warm, dark place to dry. The paper should be used within a few days after it is made, for it does not keep well.

Printing is done in bright sunlight, exactly the same as in the case of an ordinary photographic print, using either a regular negative—one preferably having strong contrast—or a pen-and-ink tracing on paper or cloth. Proper exposure will vary, but should be in the order of a few minutes. A corner of the print may be inspected for density, if care is taken not to shift it. A fully exposed print should be a fairly dark and dirty olive-green.

Washing the print in water for about fifteen minutes develops it and removes the unexposed salts. What happens chemically is this: exposure to light changes the ferric salt to ferrous; when placed in water, the ferrous salt reacts with the ferricyanide and produces ferro-ferricyanide, or Berlin blue.

A second process, in which black instead of blue tones are produced, is known as Kallitype, and was once widely used when good photographic papers were not easy to buy ready-made. It utilizes silver and is capable of fine pictorial results. In this instance a mixture of a ferric salt and silver nitrate produces, on exposure to light, an image of ferrous oxalate and silver oxide. A suitable developer reduces the image to black metallic silver.

Dissolve 75 grains of ferric oxalate in ten ounces of water that is carefully heated just hot enough to dissolve the chemical. Too much heat will spoil the salt by changing it prematurely into ferrous. Filter the warm solution and add 30 grains of silver nitrate.

The paper should be coated, dried, and exposed, as in the first process. Instead of placing it in water, however, the image must be developed in a solution made up of one ounce of borax, three-fourths ounce of Rochelle salt, and about eight drams of one-percent potassium bichromate solution. Development requires about fifteen minutes. Without washing, the print then goes into a fixing bath made up of one ounce of hypo (sodium thiosulphate), a quarter-ounce of strong ammonia, and 20 ounces of water. It is fixed for ten minutes, and then washed for twenty.

Paper is sensitized for blueprints by floating it on the solution, pushing it about a little to remove air bells from underneath it

Kallitype is developed in a solution of Rochelle salts, borax, and a trace of potassium bichromate. Blueprints need just plain water

RADIO IDEAS

Quick, three-point mounting permits this set to be hung beneath glove compartment

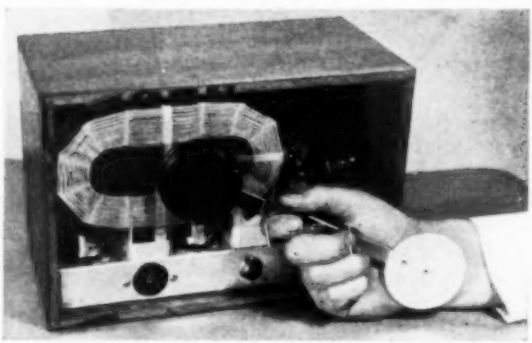
A 30-inch rod antenna telescopes into cabinet. Loudspeaker is mounted on side

Versatile Radio Quickly Adapted to Cars, Boats, Planes

EQUALLY effective as a portable or fixed set, on wave lengths from 540 kilocycles to 30.5 megacycles, a radio receiver now available will operate on 110-120 A.C. or D.C., or its own batteries. It is designed for use with any car, airplane, or boat. Where no outdoor antenna is available, there is a rod antenna which telescopes inside the case when not in use. A battery-charging device has been included, so that a set of batteries will last 400 hours. For those who want to be ready for instant reception, there is a stand-by switch which cuts plate voltage but keeps the filaments heated. The loudspeaker is mounted in the side of the cabinet, and a headphone jack is provided.

Double-Disk Aligner Checks Up Tuning of Loop Antennas

HERE is an instrument ideal for radio service or production men, or for radio fans who build their own sets. It is a loop-antenna aligner, consisting of a metallic disk on one end of a jointed bar, and a disk of high-permeability material on the other end. By placing one disk and then the other near the loop in a receiver, it can be determined quickly whether the loop is tuned properly. The two ends fold together, so that the instrument can be placed easily in a pocket or bag for carrying. In operation, the folding bar is snapped open.



One disk, then the other, is placed near the loop in checking

Stroboscopic Label Tests Phonograph's Speed

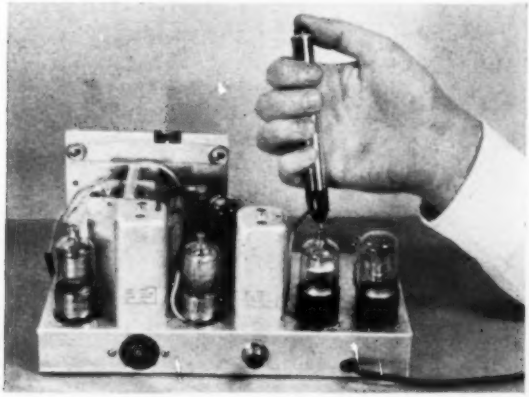
THAT OLD BUGABOO of having your recordings turn out poorly because the turntable was not rotating at the proper speed when the recording was made can be avoided by using a blank with a stroboscopic label. When the record is revolved under any light operating on a 60-cycle alternating current, the label will show at a glance when it is turning at its designed speed of 78 revolutions per minute. The disk is coated with a finish for reducing surface noise.

Telltale label, if used under a 60-cycle electric light, shows if the disk is revolving at the prescribed 78 r.p.m.

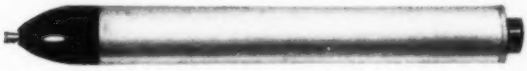
Acoustical Filter Kills Unwanted Record Noises

TO ELIMINATE objectionable mechanical noises and permit distortion-free reproduction even at low volume, an electric phonograph is now manufactured with a built-in tone guard. Of simple construction, it is merely two grooves cut around the edge of the record-playing compartment of the phonograph directly beneath the lid. In principle, it does not attempt to block out extraneous noises, but rather to capture them in the grooves, where their energy is expended without interfering with reproduction of records. A soundproof cover is built beneath the turntable.

Two grooves around the edge of the record player trap objectionable noises and cause them to spend their energy



Case of oscillator (below) is grounded through a condenser, and a touch of the prod is sufficient to test audio sections

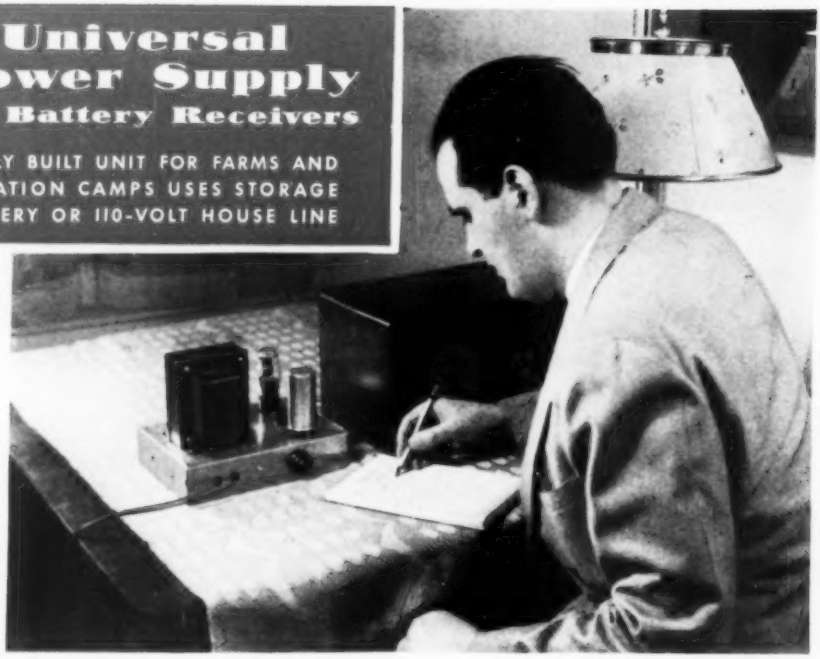


Pocket-Size Oscillator Used to Test Radio Sets

A HIGH-FREQUENCY audio buzzer that can be used as an all-wave oscillator for testing radio sets is now available in a unit the size of a large fountain pen. A short metal prod is mounted on one end, and on the other is a plunger-type switch for turning the instrument on and off. A single pen-type flash-light battery is used to operate the oscillator, and under normal use it will last several months. The output of the tester is highly directional, so the signal can be placed where it is wanted. All RF and IF circuits can be tested by touching only the tip to the wiring.

Universal Power Supply for Battery Receivers

EASILY BUILT UNIT FOR FARMS AND VACATION CAMPS USES STORAGE BATTERY OR 110-VOLT HOUSE LINE



Operating a battery radio with the power supply

The vibrator is mounted on top of the chassis with the transformer, rectifier tube, and 110-volt socket

One six-volt battery is all that is needed. It can be either a storage battery or a dry-cell unit

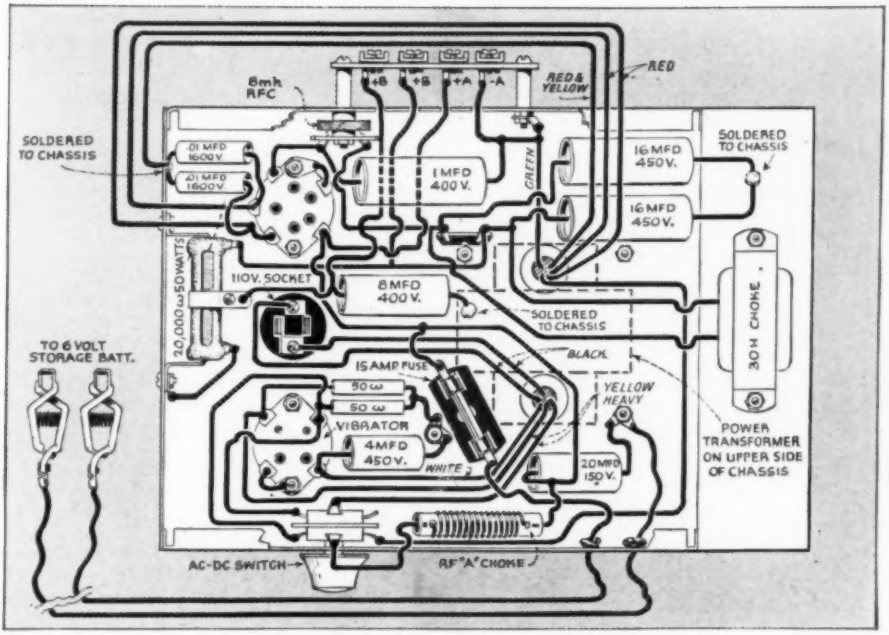
By ARTHUR C. MILLER

NO MORE worrying about "B" batteries for that battery-operated radio at the summer camp or on the farm if this universal power supply is hooked to the set. One 6-volt battery is all that is needed. And, by simply snapping a switch, the power supply can be converted to operate a battery set on 110-volt A. C.

Easy to build, this vibrator unit steps up the 6-volt power to from 100 to 300 volts for the tube-plate current. It will operate any receiver or amplifier circuit using six-volt tubes where the total B drain is not more than 100 milliamperes.

Four-tube battery receivers with 1.5-volt tubes also may be operated with this unit if the tube filaments are connected in series (4 x 1.5 volts=6 volts). However, this may be done only when the vibrator is operated off a 6-volt battery, as the heater voltage is A. C. when the unit is connected to a 110-volt line, and the unit must NOT be used on 110-volt D. C. current.

The pack is built on a steel chassis measuring 2" by 7" by 9". On top are mounted the power transformer, four-prong vibrator, 84 rectifier tube and 110-volt socket. Beneath the chassis are the chokes, resistances, and condensers.

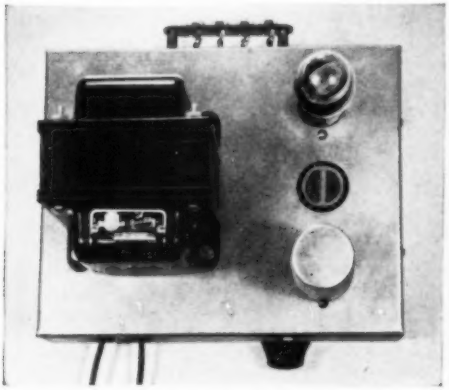


Schematic drawing of power-supply circuit. It will operate a 20-watt CW or 12-watt phone transmitter

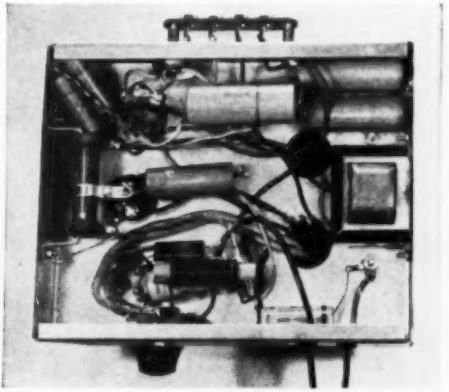
The 30-henry filter choke should pass at least 100 milliamperes to avoid overheating and damage to the windings. The 8-millihenry radio-frequency choke and 1-mfd. bypass paper condenser in the "B +" lead, and the "A" choke and 25-mfd. condenser in the "A —" lead provide the necessary RF filtering to prevent interference with the receiver. The "A" choke can be easily made at home by winding closely 20 turns of No. 14 enameled wire on a bakelite tubing with an outside diameter of ½".

A little vibrator static may be experienced when the unit is connected to a 1.5-volt battery receiver, but with 6-volt tubes no hum or vibrator static is noticeable. In each case the power-supply chassis should be connected to a good external ground and the receiver's ground connection disconnected.

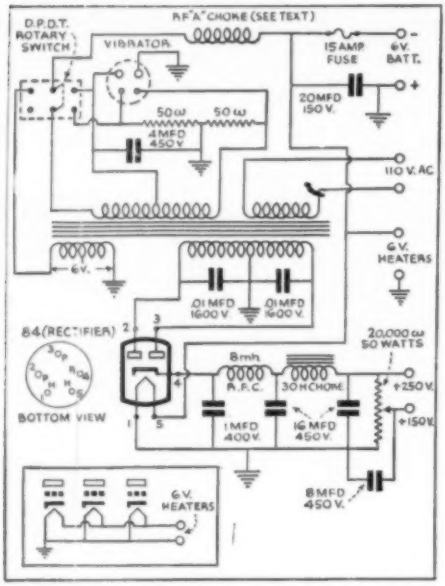
The grounded side of the tube heaters



The special power transformer makes it possible to operate a battery set on a 110-volt A.C. supply



Bottom view of chassis, showing the positions of the various chokes, resistances, and condensers



Wiring diagram for power pack. It's easy to build

must be connected to the grounded side of the 6-volt heater connections on the power unit. Do not use a "B —" lead to the unit. The "B —" connection is automatically made through the grounded 6-volt heater lead.

With an inexpensive vibrator, it is advisable to use the 300-volt tap when running the power supply off a 6-volt battery, because an inexpensive vibrator will have a low output.

PARTS FOR POWER SUPPLY

Special 6–115-volt power transformer.
Full-wave rectifier tube 84.
Four-prong vibrator.
Steel chassis, 2" by 7" by 9".
Rotary D. P. D. T. switch.
Fuse and holder, 15 ampere.
Filter choke, 30 henry, 200 ohm.
Semivariable resistor, 20,000 ohm, 50 watt.
R. F. choke, 8 millihenry.
Carbon resistors (two), 50 ohm, 1 watt.
Electrolytic condenser, 20 mfd., 150 volt.
Electrolytic condenser, 4 mfd., 450 volt.
Electrolytic condensers (two) 16 mfd., 450 volt.
Electrolytic condenser, 8 mfd., 450 volt.
Paper tubular condenser, 1 mfd., 400 volt.
Oil-impregnated condensers (two) .01 mfd., 1,600 volt.
Five-prong wafer socket.
Four-prong wafer socket.
Wire, tubing, 110-volt socket, etc.

MIDGET RADIO USES TWO DETECTORS

GREATER EFFICIENCY from the detector stage is achieved in this simple detector set by using separate tubes for detection and regeneration. It is so efficient that in some localities it will operate a small magnetic speaker.

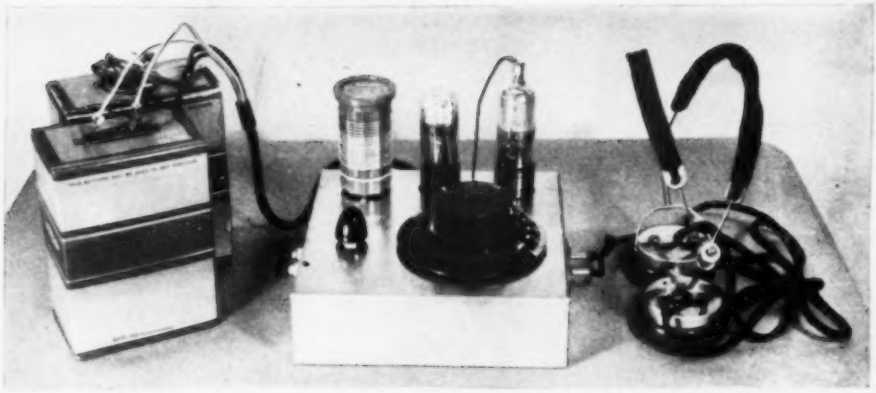
When using a screen grid or even a pentode in the detector stage, it is necessary to apply a low "B" voltage on the screen, sometimes as low as 22 volts, so the tube cannot be operated at maximum efficiency. However, with this arrangement of a separate triode tube for regeneration, 67½ or even 90 volts can be applied to the screen.

The one-tube detector stage may also be used as a medium-power audio amplifier for a crystal pick-up. The pick-up must have an output of at least 1½ volts, preferably 3 volts. The clip on the grid cap of the 1N5G is removed and one lead (unshielded) of the pick-up is connected to it, while the other lead (shielded) is connected to the chassis. Phones, a small magnetic speaker, or a PM speaker (5-inch) may be used to listen to phonograph recordings.

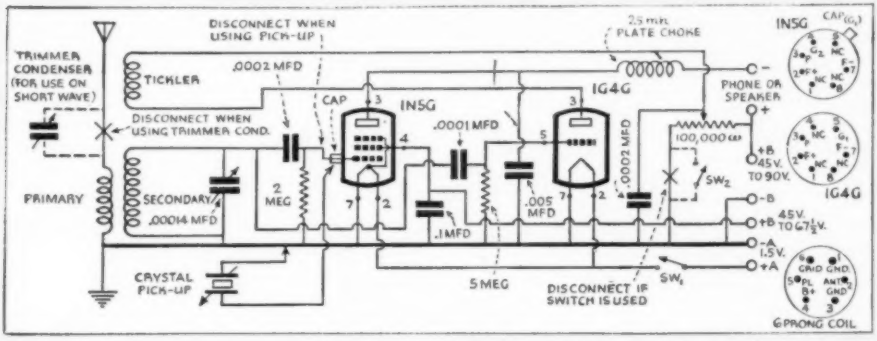
A 100,000-ohm potentiometer is used to control regeneration. One side of the control is grounded to the chassis. As this puts a resistance across the "B" battery, even when the receiver is not in use, and causes the "B" battery to run down sooner, it is advisable to include a switch, as shown in the diagram (SW2). Instead of buying two S.P.S.T. switches, a D.P. S.T. may be used.

Any good antenna and ground installation may be used with this set. However, if the amateur has not, as yet, an antenna rigged up he can test the set with a 20-foot piece of wire lying on the floor. Short waves may be received on this radio with suitable plug-in coils. In this case it is advisable to use a small trimmer condenser in the antenna lead (.00005 mfd. or 50 mmfd.).

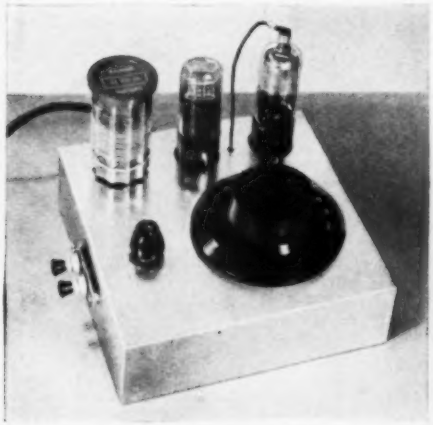
A 7" by 7" by 2" steel cadmium-plated chassis is used, and, by mounting the tuning controls as shown in the photographs, the metal panel can be dispensed with, thus cutting down the cost.

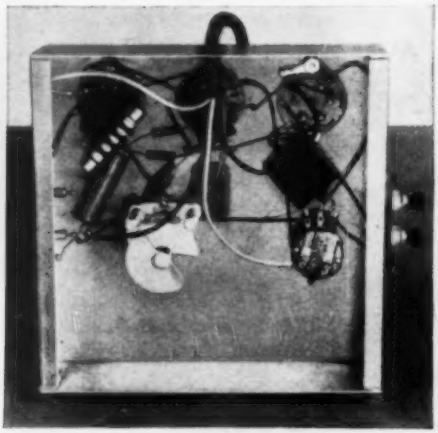


Separate tubes for detection and regeneration give this simple receiver its remarkable efficiency



How the circuit is wired. Any good antenna and ground installation may be used with this set





Top and bottom views of chassis. By mounting the controls thus, the metal panel is dispensed with

CENTENARIAN. The name signed to this camera character study of an old woman's furrowed face is that of a veteran news photographer, salon exhibitor, and picture judge—William H. Zerbe, F.R.P.S. His prints have hung in photographic salons the world over

What a Picture Judge Looks for in a Print

Popular Science Interviews
Photographer William H. Zerbe

A NEWS photographer by profession, a photographic artist by choice, William H. Zerbe has been taking pictures since 1884 both as a business and a hobby.

Today, still an active member of the staff of the "New York Herald Tribune," he ranks as a dean in both fields—a veteran among news cameramen and salon exhibitors alike. His own prints, many of them made on day-by-day journalistic assignments, have been exhibited in outstanding photographic salons all over the world. And for many American salons he has been chosen as a member of the judging committee.

A trim, gray, smiling little man, Mr. Zerbe has taken all types of photography as his province, and disclaims any specialty. The nearest he ever came to specializing was many years ago, when he went through a phase of being fascinated by the possibilities of fire pictures.

"I learned to look for the pictorial quality as well as the news element," Mr. Zerbe explains. "Sometimes both elements came together—more often I made my news shots and then tried a little harder for something else."

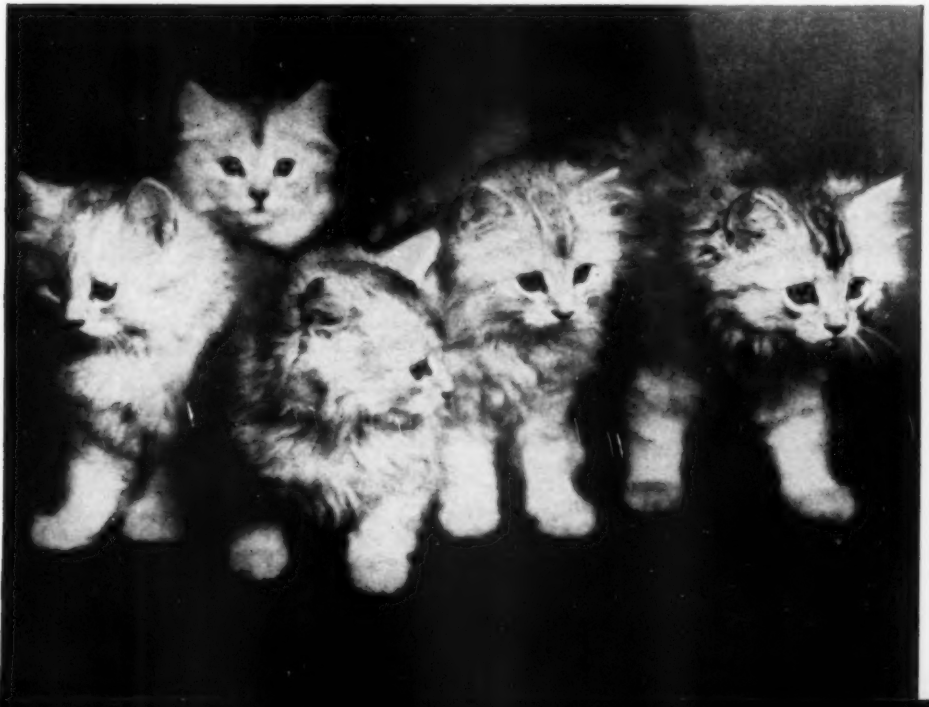
He will laugh reminiscently as he looks over some of those prints . . . "I had to get up on the next roof and climb a water tower for that angle!"

Back in those days Mr. Zerbe would turn in his plates from an assignment, make the prints his newspaper wanted for news pictures, then put aside the negatives he thought had promise. With these, sometimes many weeks later, he would turn out prints of a very different type, sometimes masking off large parts of the negative or experimenting with various mediums and techniques of printing.

It would be a mistake, nevertheless, to assume that all of his serious works developed as by-products of news assignments. On the contrary, he experimented continually with all kinds of photographic ideas—portraiture, landscapes, still life, and all the rest.

In all his photography, he strove to analyze and apply the same basic principles of composition and form. He concentrated

A HAPPY FAMILY. Cats and kittens have given Zerbe many an appealing print. He has tried his hand at countless subjects . . . knows by personal experience the things that really count



COBBLESTONES AND SURREY WHEELS. It takes the eye of an artist to see a beautiful composition in a simple subject like this

until he was able to frame a mental composition almost instantly, without squinting through the camera. This kind of automatic visualization was almost necessary in cases where speed counted. A news photographer's equipment years ago was far bulkier than it is today—many of the best Zerbe on-the-spot pictures were made with the old hood-type Graflex, and *that* was a great improvement on previous equipment.

But can Mr. Zerbe give younger photographers fixed rules on how to achieve composition? Of course he can't. There aren't any fixed rules, he explains, except the old familiar ones about originality, simplicity, keeping the picture uncluttered, and concentrating on the true center of interest.

"There are some pictorialists now who say the whole principle of composition is the bunk—that it means nothing and can be disregarded," Mr. Zerbe smiles. "I know some of them. They are excellent photographers and do fine work, too. And what's more, all their good pictures show fine composition! It's there and they don't know it.

"They have a natural feeling for the sound principles of composition, and they apply those principles without even thinking about it or realizing the process. Any imitator who tries to follow their technique without possessing the same kind of inherent skill and sense of form will get nowhere. In the last analysis, you know, a good picture is like a good story: if the words are jumbled and tossed around haphazardly, the result is confusion, and means nothing. But if the words are rightly arranged, the sound effect comes through."

Honors rare among press cameramen have come Mr. Zerbe's way during his salon career. He is, for example, a Fellow of the Royal Photographic Society of Great Britain, and of the Photographic Society of America. For 26 years he has served as instructor and lecturer on photography at the Brooklyn Institute of Arts and Sciences. He is an executive member of the Oval Table Society, and holds honorary membership in more clubs than we could possibly list here.

He is known as a long-time contributor and judge in many famous photographic salons. Because of this, serious amateur photographers often ask what they should aim at in preparing prints for submission to salon judges. In other words, what makes a fine salon print? It is admittedly a tough question, touching on certain intangibles that cannot be reduced to logic or to formula. Here is the most definite answer Mr. Zerbe can give:

"*Originality in subject* always gets the attention of the judges. Then *good composition* and *simplicity* of arrangement are important. And so are the *technical* factors—perfect printing and processing, which give the picture *print quality*.

"Finally there is the important matter of *imagination*. If the photographer can manage to convey to the judges the mood or

scene as it impressed him when he made the picture, that greatly increases the chance that his print will be chosen in any competition."

As for the technical method of judging prints for a salon, Mr. Zerbe has found this system best, and recommends it as being just as sound for an amateur camera club, holding its first jury show, as for any well-established national salon:

Pick your judges (three is a good number) and seat them comfortably facing a well-lighted easel or stand, far enough apart so that they don't distract each other's attention. Arm each with a set of cards numbered from one to ten. It is well to pass the entire list of prints hurriedly before the judges, to give them a general idea of the number and quality of pictures to be considered. Then go through the list more slowly, placing each print on the stand for a moment of study. Each judge then holds up a card to rate that picture in the one-to-ten scale, and the totals are noted by a clerk. The judges do not see each other's cards; nevertheless, it is remarkable to note how close together these judgments usually will be. The rating process can be repeated so far as necessary to eliminate lower-ranking prints until the collection is whittled down to the size that can be shown.

The conference system of selection, in which the judges view the prints together and discuss them, is less fair, in Mr. Zerbe's opinion, because it usually happens that one judge will more or less dominate and enforce his own notions.

One more word about Mr. Zerbe: He never gets enough of photography. His idea of a perfect vacation is to take pictures in Mexico; an ideal Sunday recreation is to join a crowd of ardent amateurs on a camera train trip up into New England.

CONCENTRATION. Zerbe has turned many a news shot of a fire into a salon print. This was exhibited at the New York World's Fair

Not the least interesting part of his exhibition pictures is the back, often completely covered with salon labels

By W. GUY PEARCE

Director of Make-Up,
Twentieth Century-Fox Studios

SPECIALIST IN MAKE-UP

After serving as a Royal Flying Corps pilot over the Western Front during the first World War and doing a five-year hitch with the Royal Canadian Northwest Mounted Police, W. Guy Pearce went to Los Angeles in 1925 with the idea of practicing law. Instead, he has spent the last 15 years preparing actors and actresses for the camera. He makes up such stars as Tyrone Power and Alice Faye, and is one of Hollywood's best-known make-up experts. In this article he tells how much . . . and how little . . . paint and powder you should use before facing a camera

Make-Up for Home Movies

MOVIE make-up has undergone a revolution in recent years. Often male actors, especially the tanned he-man type, appear with no paint and powder whatsoever. Actresses, excepting for character parts, may face the cameras as though dressed for the street. Delicacy is the watchword of Hollywood's make-up artists. That word holds the key, likewise, to the filming of satisfactory home movies.

We employ considerable ingenuity and legerdemain to transform actors into characters of many types, from Indians to ancient patriarchs. Usually, however, we are concerned with making eyes look larger and more brilliant, narrowing broad noses and broadening thin noses, and bringing greater beauty to already lovely lips. These are problems every home-movie fan faces. Unlike the Hollywood expert, however, he seldom does anything to alter facial features.

The answer is simple. You need only a few materials, available at all drug and dime stores. Given a little practice, you can achieve amazing results and make your pictures more interesting and real. A little make-up, judiciously applied, does make the

average human look healthier and handsomer on the screen; and most of us need that help because we are only average as compared to the professionals, whose natural appearance is one of the assets that makes them what they are.

First step in making up your "actors" is the application of a base. I prefer water color, which comes as a flat pancake. Sponge the base over the entire surface of the skin, from collar line to hair line. After the base dries, which requires only a few seconds, smooth it carefully with a soft powder brush of the type women use in the home. Brushing removes streaks, leaving an even surface.

Second, apply the eye shadow. Use brown for brunettes, blue-gray for blue- or gray-eyed people. These colors are satisfactory for both black-and-white and colored films. Blue-gray brings out the blue in blue-eyed girls, and is more flattering than brown to the gray- or green-eyed person. Many women use eye shadow for evening wear, thus improving the smartness of their appearance. For photographic purposes the shadow should be applied in exactly the same manner, but more delicately—just enough to convey a suggestion of shadow.

Third, darken the eyebrows. Using a brown (not black) pencil, sharpened to a fine point, draw a line across the lid close to the base of the lashes, and with the finger tip blend it into the shadow. The object of the pencil is to suggest a shadow cast by the lashes, which makes the lashes appear more luxuriant. Repeat this process under the lower lashes. With the same pencil, now extend the line of the eyebrow outward slightly, say ⅜". The average eyebrow stops too abruptly, and this line will improve the shape markedly.

As a *fourth* step, apply the cheek rouge. This is most easily handled in the dry form, especially when working over a water-color base. Although a pad is supplied by manufacturers, I recommend using a brush. Also, keep your rouge and powder brushes separate, because the rouge cannot be removed easily from the bristles.

How and where should you use rouge? And how much is needed? Apply it sparingly and brush delicately. Exactly where depends upon the bony structure. On a round face, the rouge should be kept fairly close to the nose, which tends to make the

AS DEMONSTRATED by Pearce on Barbara Lynn, young Hollywood actress, the water-color base is applied by sponging over the entire surface from collar line to hair line. When dry, the base is smoothed with a soft-bristled powder brush

EYE SHADOW IS NEXT APPLIED and smoothed with the finger tip. Brown is used for brunettes, blue-gray for blue- or gray-eyed girls. These colors are satisfactory for both black-and-white and colored films, but care must be taken to use them delicately

face look thinner. On a thin face, carry the rouge well out on the cheek, particularly if the person has a large nose. At all costs, avoid a round splotch.

Color films tend to exaggerate rouge, while black-and-white gives the illusion of hollow cheeks, suggesting illness. Fact is, rouge is not needed at all for black-and-white photography. In any event, smooth the rouge away delicately until it fades into nothingness, and use less than ordinarily is applied for street wear.

Fifth, forget the natural lips. By that I mean, disregard the shape of the mouth and discover by experiment the most becoming contours—those best suited to the type of individual and her natural features. Viewed in that aspect, the make-up of the lips is most important. For black-and-white film, use the same rouge as would be worn on the street. For color photography, select a rouge two shades lighter than ordinarily employed, avoiding deep carmines in both cases, as red photographs much darker than its actual tint.

You can do several tricks with mouths to improve their beauty. In case of a thin upper and full lower lip, carrying the lip rouge above the natural line will increase the upper lip and give a more even combination. Reverse the process with a thin lower lip. Tiny mouths may be enlarged by painting both above and below the natural line, and extending the points farther out. Mouths which droop at the corners will smile if you narrow the lower lip and paint the corners slightly upward. This simple change will help amazingly to give a happier expression, which is what most folks desire when producing pictures of their families.

Here's another little point we use often: The lower lip normally picks up light from above, leaving the upper lip in shadow, particularly when photographing in sunlight. On the screen, the lower lip looks much lighter. To remedy this emphasis, paint the upper lip two shades lighter.

Sixth . . . return to the eyes. Observe carefully the accompanying pictures showing Barbara Lynn, young Twentieth Century-Fox actress, being made up for an appearance before my 8-mm. home movie camera, with which I take frequent tests on color film to observe the results of my work. In them you will see graphically what I shall describe.

THE EYEBROWS should be darkened after the upper and lower lashes have been shaded. At the same time extend each eyebrow a short distance to improve its shape. Note difference between the extended brow over the right eye and the normal brow over the left

AFTER ROUGE has been applied to the cheeks and the mouth has been painted with lip rouge, it is necessary to return to the eyes. Brush mascara on the upper and lower lashes, using brown, not black, because jet-black lashes are quite rare

After the shadow has been applied, brush mascara onto both upper and lower lashes. Use brown, not black, because few persons have jet-black lashes. Only Latin types may coal-black their lashes successfully. Mascara is the magic wand of the eyes. Its proper application causes the lashes to become frames for the eyes, often converting an average girl into a beauty.

Now, if the eyes look too small, there's a remedy. Slope the lower shadow line outward to meet the upper, leaving a tiny triangle of light at each corner. This triangle may be filled in with white grease or light base. But never, never reduce large eyes. Also, never pluck out the brows. Keep them neat, as a man shaves, by removing the wild and nose brows. This simple procedure gives a well-groomed appearance for close-ups.

Seventh, give broad noses a little absent treatment and bring additional body to thin noses. A broad nose is helped by applying on each side a base two shades darker than that on the face so it runs from the corners of the brows straight down to the tip and fades away on the sides. To broaden a thin nose, apply a base two or more shades lighter, blending it smoothly toward the sides. To shorten a long nose, apply shadow between the upper lip and the tip.

Here are two final tips: Double chins often take on grotesque appearances, especially in close-ups. What to do! Sponge a darker base under the chin, fading it away to nothing on the neck. As for broad jaw lines, extend the shadow up to the cheek bone, again using a shadow two shades darker than elsewhere on the face. As all good photographers know, dark recedes and the high lights become prominent. It is thus possible to illuminate and emphasize the desirable features.

This technique, which is followed in general principles by all Hollywood's skilled make-up artists, is quite simple to master. There is no mystery to it, and care and careful observation are the main requirements. A little practice should make you perfect.

Men generally require the base, but no rouge. Otherwise, these practices apply equally to men and women. By observing them, you'll find the characters in your pictures expressing greater vitality and personality. Which makes for more interesting productions.

BROAD NOSES may be made to look thinner by applying on each side a base two shades darker than that on the face so that it runs from the corners of the brows straight down to the tip of the nose and fades away delicately on the sides

PEARCE TAKES TEST SHOTS of Miss Lynn on Kodachrome with an 8-mm. camera to check the results of the make-up process. He keeps the camera handy for this purpose because he frequently follows the same practice when making up a star for some new part

Winning Entry IN OUR Funny Photo Contest

The grotesque, bloated shadow cast by a girl on a wall provided Ernest Robson, of Lafayette, Ill., with the humorous subject that won the $25 prize

HERE'S the winning entry in the funny photo contest that was announced in the January issue of POPULAR SCIENCE. Ernest Robson, of Lafayette, Ill., won the $25 prize for a study in shadow entitled "Beauty and the Beast."

There were a lot of laughs in examining the hundreds of photographs submitted, some of which were taken ten or twenty years ago. In spite of the many examples of good photographic work, the judges were reminded, however, that getting humor down in black and white so there's a laugh in it for everyone is a lot harder than most persons suspect.

Four other entries were selected by the judges as being worthy of honorable mention. They were submitted by V. A. Bovik, of Elmira, N. Y.; Frank Hegemeyer, of Monterey Park, Calif.; Herman Rubenstein, of Philadelphia, Pa., and Miss Helena Lugowski, of North Arlington, Mass.

NOW TRY FOR $25 *with your best* PORTRAIT PHOTO

Good portrait photography is no cinch, but we believe there are hidden talents for this type of camera work among our readers. Here's your chance to help us find out if we are right, and perhaps win a cash prize at the same time. For the best portrait photograph submitted on or before May 15, 1941, we are offering $25. Mail your entry to the Photo Editor, Popular Science, 353 Fourth Avenue, New York, N.Y.

Any subject is eligible—man, woman, or child. The portrait may be of whatever type you please, and as much of the figure may be included as you wish. And if you note on the back a few details as to how the shot was made—the camera and film used, the lighting, and the exposure—so much the better. Limit the print size to 8" by 10", preferably on single-weight glossy paper. No photos returned. Editors' decision is final. In case of a tie, duplicate prizes will be awarded.

FOR CAMERA USERS

Two commutators insure synchronization between recording disk and film

VOICE AND MUSIC can be added to amateur movies with split-second accuracy by means of a new device that automatically synchronizes the film and recording disk. Any 8- or 16-mm. camera and projector can be altered so synchronizing units can be attached or detached, as desired. If a recorder is already on hand, a turntable unit can be obtained to adapt it for use.

Talking pictures can be made of family and friends, or sound can be added to scenes taken previously. Synchronized sound-on-disk for a five-minute reel costs about one dollar and, according to the manufacturer, is equal to the best sound-on-film. Each recording can be played back immediately, and records can be edited to match the finally edited film.

POLARIZING FILTER. Guesswork is eliminated in placing the filter shown below before the lens. A pivot on the clamp which holds it to the lens permits it to be swung above the lens for viewing the scene. It is then rotated to obtain the desired effect and swung back through 180 deg. to place it before the lens in the same relative position it had when used visually.

THREE-STAGE ENLARGING BULB. For greater convenience in enlarging, a two-filament lamp is now made that gives illumination of 50, 100, or (when both filaments are switched on together) 150 watts. Additional light can thus be obtained as needed. The new bulb has a three-contact medium screw base that requires a special socket. This socket is, however, the same size externally as the conventional socket, so the substitution is easily made. The average life of each filament is 100 hours, and the lamps can be used in any position.

Developing Solutions Filter Quickly Through Glass Coffee-Maker Top

DO YOU hesitate to filter your photographic solutions because it is slow work to keep the funnel full while the liquid oozes through drop by drop? Then use a discarded or extra glass top of a vacuum coffee maker as a funnel. These come in various sizes, and for this purpose, the larger it is, the better. Just fill it once and leave the solution until it runs through. Regular cloth coffee filters may be used instead of ordinary filter paper, if desired. If this is done, be careful to have a separate filter for each type of solution—developer, hardener, and fixing bath—and rinse it out after each use. Label each filter. To avoid any possibility of contaminating the coffee, set aside the funnel exclusively for photographic purposes.—K. S.

A discarded or extra glass top from a vacuum coffee maker is an excellent filter because of its size. It can be filled up and left until the solution filters

Negative Holder Has Grid for Focusing

EQUIPPING a negative holder with a permanent focusing grid as shown below will save time in using an enlarger. This can be done by drilling a 3/16" or ¼" hole through both leaves of the holder as close to the opening as possible, but take care to allow room for the negatives. Scratch a few lines on a small piece of darkened negative and fasten it over the hole with rubber cement or Scotch tape. The image of the scratches will appear on the easel beside the negative to aid in focusing.—A. H. HONEST.

A small piece of blackened negative, with lines scratched across it, is fastened over a hole drilled through both leaves of the negative holder

Ordinary Corks Covered with Rubber for Use in Chemical Bottles

BOTTLES containing photographic or other chemical solutions may be stoppered by cutting a piece from an old rubber glove and placing it over the bottle neck before the cork is inserted, as shown in the photograph at the left above. Another and more convenient method is to cut a finger from the glove and stretch it over the cork, as at the right.—ROBERT SCOTT.

Test Strip Focuses Movie Projector

A MOTION picture projector can be focused beforehand by means of a piece of clear film about 8" long, down the center of which a line has been drawn with a ruling pen. In setting up the projector, open the gate and insert this strip of film. With the motor off and the lamp turned on, throw the image of the ruled line on the screen and focus the lens until the line appears sharply defined. Remove the strip and proceed to thread your film in the usual manner. The prepared strip may be attached inside the projector case with masking tape so that it will always be handy.—H. R. S.

NEW AUTO-LITE "PLUG-CHEK" FOR SPARK PLUGS

GIVES VITAL FACTS OF MOTOR PERFORMANCE!

HOW AUTO-LITE "PLUG-CHEK" WORKS TO PEP UP SLUGGISH MOTORS, SAVE YOU MONEY ON GAS!

THOUSANDS HAVE REPLACED WITH WRONG TYPE SPARK PLUGS—AND DON'T KNOW IT!

HERE'S a new service for motorists. A scientific device called a "Plug-Chek Indicator," helps every Auto-Lite dealer spot, more easily than ever before, plugs that are functioning improperly or have burned or fouled because of engine irregularities. If your motor is sluggish, lacks pep on the hills, fails to get away fast, ask your Auto-Lite dealer for a "Plug-Chek." He compares the "business end" of your spark plug with the "Plug-Chek Indicator." This reading enables him to better analyze your engine operation, helps him restore top engine performance, end costly gas waste. Ask about the new Auto-Lite Spark Plug that's "Ignition Engineered"—and be sure to get a "Plug-Chek" today!

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TOLEDO, OHIO • *Merchandising Division* • SARNIA, ONTARIO

One Out Of Every 4 Cars is Factory-Equipped with Auto-Lite Spark Plugs

AUTO-LITE *Ignition Engineered* SPARK PLUGS

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Everywhere

Dear Folks:

Some call me the "Hastings Tough Guy". Others refer to me as that "Tough But Oh So Gentle" fellow. Either way, I'm your friend -- for I show you how to save money on oil and repairs; how to restore lost performance to your motor.

Millions of car owners have accepted my recommendation of Hastings Steel-Vent piston rings -- the rings that are "tough on oil-pumping, gentle on cylinder walls" -- and they are my grateful friends.

If you are having oil-pumping troubles, I can help you too. Just go to your motor service man, and tell him to install a set of my kind of piston rings.

Gently yours,
The Tough Guy

HASTINGS
STEEL-VENT PISTON RINGS
Stop Oil-Pumping
IN CARS, TRUCKS AND TRACTORS

Gus Learns Something New

(Continued from page 142)

but not quite missed connections. Naturally, when the pump arm misses the cam the pump doesn't function, and your engine goes dead because it isn't getting any fuel."

Tim studied the pump arm for a moment, and then nodded agreement. "You're right—as usual," he conceded. "Say, old Hawk-eye, don't you ever miss 'em?"

"Sure I miss 'em," Gus said modestly. "Every one in this business misses 'em now and then. If I hadn't happened to spot that sliver we'd have been fooling around for another hour trying to find out what ailed your bus. Well, let's fix it—that's easy!"

He clamped the arm in the vise on his workbench, and tapped it carefully with a machinist's hammer until it was back to its normal shape. Then he reinstalled the pump on the car. With the pan still off, it was easy to see that the pump lever now rested properly on its drive cam.

Tim looked grateful. "Thanks, Gus," he said. "Don't forget that I'm going to pay you for all this."

Gus scowled at him. "Pay me?" he growled. "You don't owe me anything. Now don't start a fool argument! I guess I can help Bill Knudsen along in his defense job by getting a workman back to his airplane-engine plant, can't I?"

How To Protect a Home from Air Attack

(Continued from page 80)

setting fire to the magnesium casing, which burns for 15 minutes. All litter, lumber, and paper should long since have been removed from the attic and the woodwork should have been made fire-resistant by applications of two coats of whitewash, consisting of slacked lime, one ounce of common salt, and a pint of water. Fire-fighting materials—buckets of water and sand, a long-handled shovel, and a hose and pump—should be kept on hand in the refuge room.

Incendiary bombs can be extinguished by covering them with sand and then lifting them with a shovel and placing them on top of sand in one of the buckets. Or a spray—not a stream—of water can be directed on the bomb, causing it to react more violently and burn itself out in a short time. The water method has its dangers, as a stream of water played directly on a bomb may cause it to explode and project molten metal for 15 or 20 yards.

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WHAT a thrill it is for every man's family—the happy realization of owning a new car! But remember... you don't buy a new car every day, so it's wise to figure the whole deal by yourself before you put out any money.

Just send the coupon below for the GMAC Figuring Chart that gives you all car financing details in dollars and cents... shows exactly what you get for what you pay! With this simple chart you can figure your own transaction... based on the amount of time you want and the amount you wish to pay monthly.

Notice the *low cost* of the General Motors Instalment Plan—and the broad insurance protection for your car which it includes. Compare it with similar finance plans and what they offer. This way, you see just where and how you save!

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IT'S TENITE . . . .
hard, durable, *weatherproof*. It won't warp, swell, split, or crack. You'll like the natural "feel" of its well-shaped grip. Its single trigger fires either barrel simply by moving the handy "barrel selector" up or down.

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Free Catalog

Write: J. Stevens Arms Company
Division of Savage Arms Corporation
Dept. SM-242, Chicopee Falls, Mass.

STEVENS

Pursuit Pilot

(Continued from page 58)

It is almost impossible to shoot down one of these fast modern planes from the side, because it is moving too fast. The attacker must get on the tail of his quarry to be successful, and fire from fairly close range with the guns fixed in the leading edge of his wings. But when planes are in the defensive circle, each one is protecting the tail of the one ahead. The attacker can't get a good shot without exposing his own tail, and if he keeps away, his shots go ineffectually tangent to the circle.

The telephone rang. Lieutenant Cochran was wanted right away at Operations. Meanwhile, waiting for a chance to go on with our conversation, I talked with some of the youngsters he had been training. They had been in the Air Corps more than a year now, had been second lieutenants with wings for four months. But still they had not progressed beyond the ABC stages which have been described in this article.

These boys were all eagerness to get on to their next steps—dogfighting, gunnery, and tactics. I was eager to learn about these things too, and eventually did. But meanwhile I had begun to realize why it is you can't make a military pilot in a year's training, no matter how intensive. And I realized you can't tell about it all in one short article, either. I'll tell you more about it next month.

C.A.B. Warns Dozing Pilots

"DON'T be a dozer," the Civil Aeronautics Board warns pilots in a recent bulletin.

"You wouldn't attempt to sleep peacefully while driving your car down Main Street. Then, why slumber while your plane glides along in the airport traffic lane? On the ground, danger comes from four directions—both sides, ahead, and behind. In the air, add two more—above and below. Add to that the fact that planes, to a greater degree than cars, have blind spots."

Question Bee Answers

CHECK your answers to the Question Bee on page 72 with the list below. Give yourself ten points for each one you had right. A score of 70 is good.

1. c	2. b	3. d	4. a	5. b
6. c	7. d	8. c	9. d	10. b

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Are also in this "Champion" Portable

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● Shaped from finest hammer steel to perfect dynamic form by the 80,000 pound blows of a giant forging hammer, this TRUE TEMPER Dynamic Nail Hammer is at once the most durable and most efficient tool that can be produced for carpenter work.

It is finished in satin smooth, rustless black, as are all TRUE TEMPER Dynamic Tools, and fitted with a professional design, all white hickory handle. On sale at all good hardware stores. Sent direct, postpaid, if not yet stocked by local merchants. Produced only by the makers of TRUE TEMPER Products.

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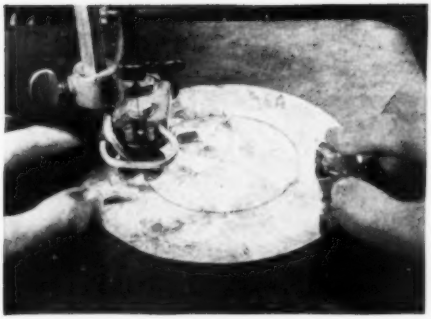


Cutting Out Sheet Metal Disks on a Scroll or Band Saw

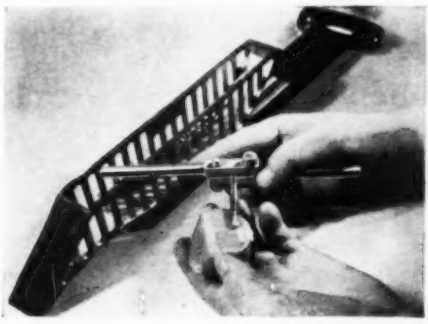
WHEN a number of thin metal disks have to be cut on a scroll or band saw, the work can be done much faster if the center is deeply indented with a prick punch. This causes a projection on the underside that will rest on the saw table and form an axis around which the metal turns freely and accurately.—K. M.

Preparing Rubber for Patching

TO ROUGHEN the surface of an inner tube, hot-water bottle, football bladder, or other rubber article before applying a patch, either a wad of coarse steel wool or a wood rasp is better than the usual tin scraper.—O. B.

How to Tap Aluminum Alloys

MANY mechanics find that it is difficult to tap perfect threads in aluminum and light alloys containing this metal. A method used by a pump engineer is first to fill the threads of the tap, particularly those at the end, with ordinary yellow beeswax. He says that good threads can then be cut without difficulty even in thin stock.



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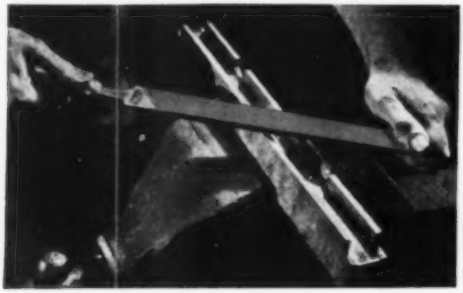

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"Get it going and get it done!" is the order of the day on national defense production in thousands of foundries and machine-shops. Here's a file that can "step along" under that sort of command! . . . It's the special-purpose Nicholson or Black Diamond Shear Tooth—a long-angle single-cut file that combines fast metal-removing speed with excellent finishing qualities.

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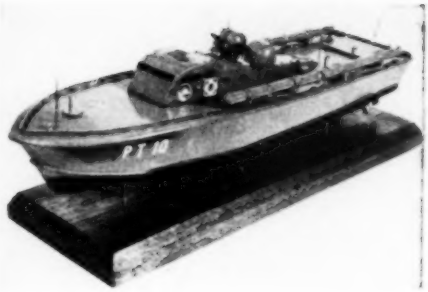

Mosquito-Boat Model Built from New Kit

NEWEST defense weapons of the United States Navy are the speedy little ships of the Motor Torpedo Boat Squadron, or "Mosquito Fleet." This 3/16" scale model of the P.T. 10 can be built from our new construction kit 12S, which includes a shaped hull, finished fittings, and all necessary material, and is priced at $5.00 (25 cents more west of the Mississippi River). The model, 13" long and 4" high, makes a striking ornament. Kits for other ships, miniature rooms, and whittled novelties are also available. Send a stamped, self-addressed envelope for a complete list.

A.	Whaling ship WANDERER, 20½" hull, 27" over all	$7.10*
H.	Cruiser U.S.S. INDIANAPOLIS, 12" long	1.50
L.	Farragut's flagship HARTFORD, steam-and-sail sloop-of-war, 41" over all	8.45*
R.	U.S. cruiser TUSCALOOSA, 11⅝" long	1.00
2S.	U.S. Navy destroyer PRESTON, 31¼" long	5.95*
4S.	Clipper ship GREAT REPUBLIC, 31½" hull, 42" over all	8.40*
10S.	Confederate raider ALABAMA; steam sloop, bark rigged; 21½" hull, 28" over all	8.20*
12S.	Motor Torpedo Boat P.T. 10; a 13" exhibition model (not a working model); shaped hull, propellers, ventilators, etc.	5.00†
S.	Whittling kit for six different Scotties; each is 2" by 2¼", sawed to shape	1.00

Note: If you live west of the Mississippi River, add 50 cents to prices marked with an asterisk (*) and 25 cents to prices marked with a dagger (†).

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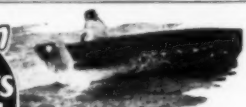

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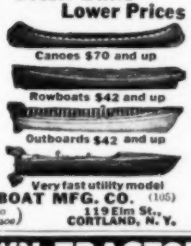

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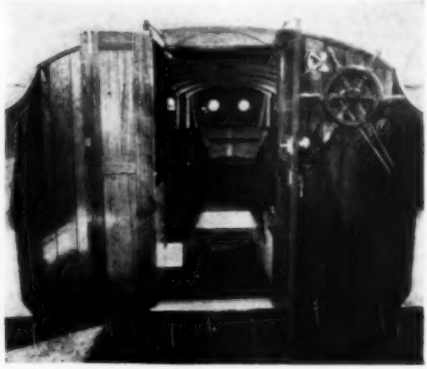
Cabin Cruiser, 17' long, weighs 750 lb., for use with outboard or inboard drive, 356-357-358-359-R..... $1.50
Folding Duck Boat, 13' long, 170-R..... .50

(Continued on page 229)



Looking forward into the cabin of the cruiser shown above. It is powered by an outboard motor

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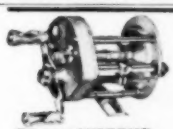

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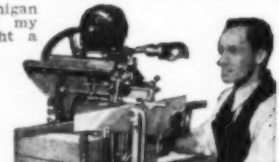

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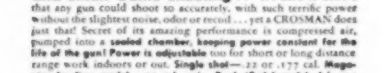

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(Continued from page 226)

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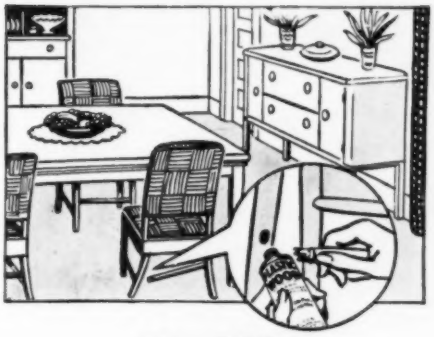

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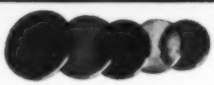

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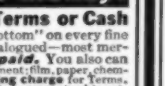

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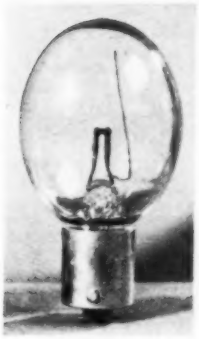

A NEW photoflash lamp known as the "speed midget" produces such a brief flash that it freezes moderate motion and greatly simplifies the problem of synchronization. The flash lasts only 1/100 second. The peak is reached in 1/200 second, which is four times faster than with the ordinary No. 5 midget bulb. Although the light produced is only about one fourth as great, it is said to be ample when used with the fast films now available. No aluminum leaf, free wire, or shredded foil is used within the bulb. Instead, a chemical paste is applied to the ends of the lead-in wires.

It is easy to synchronize the lamp with nearly all types of manually set shutters because the flash is so fast it does not have to be given a head start. Even with a box camera, good pictures of moving objects can be taken at distances of from 7′ to 8′, and with better lenses at 20′ or more.

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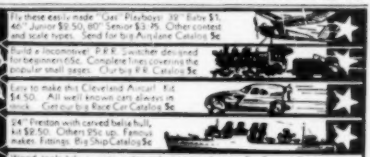

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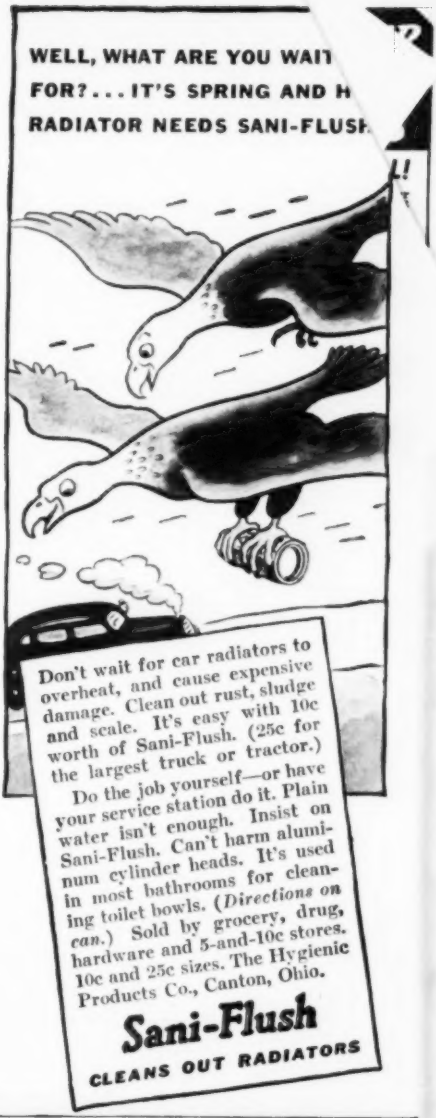

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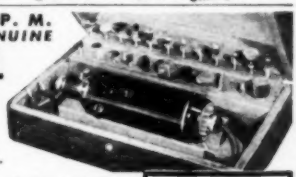

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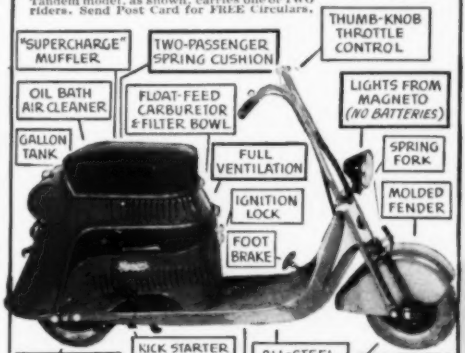

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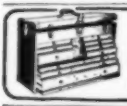

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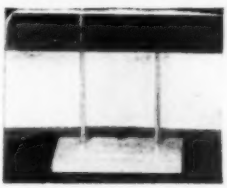

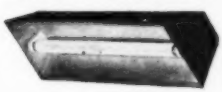

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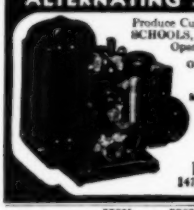

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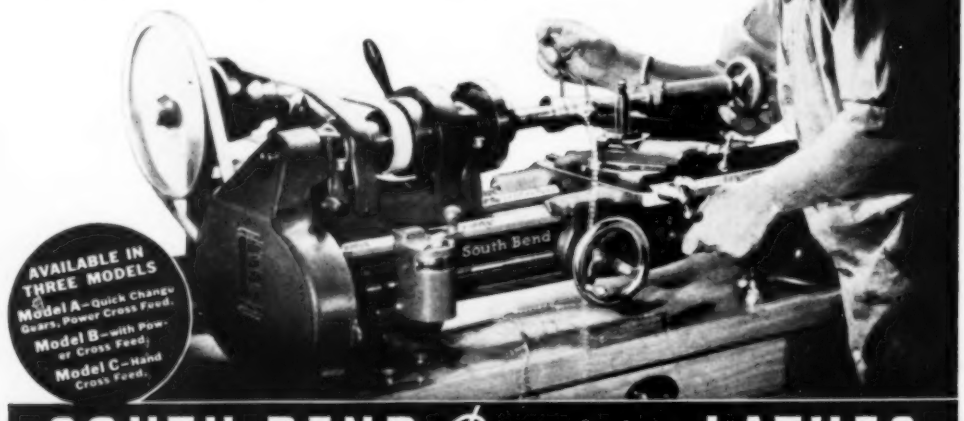

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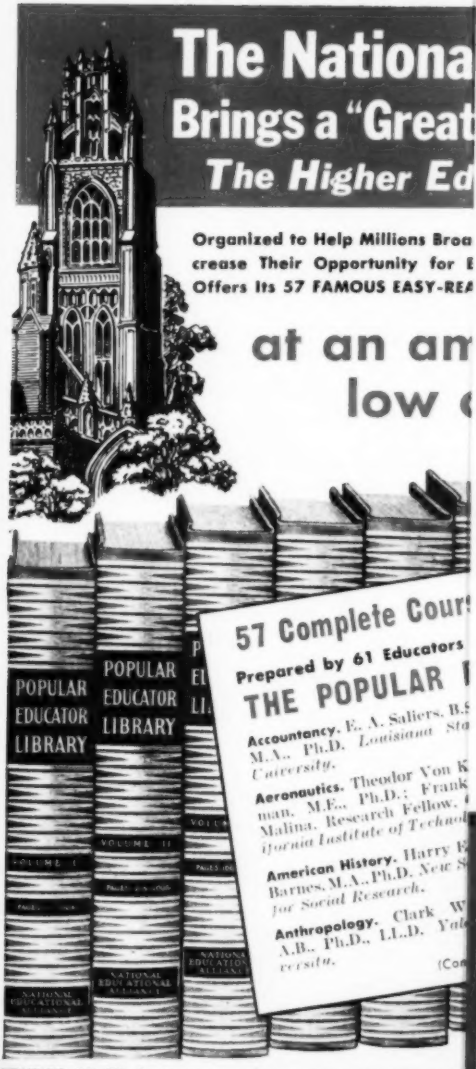

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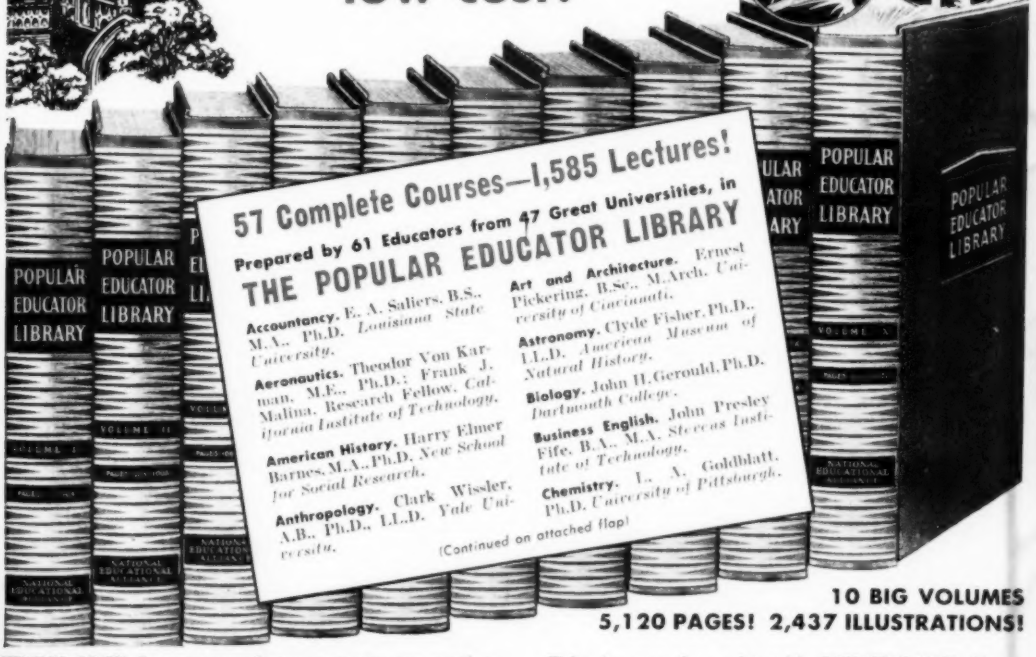

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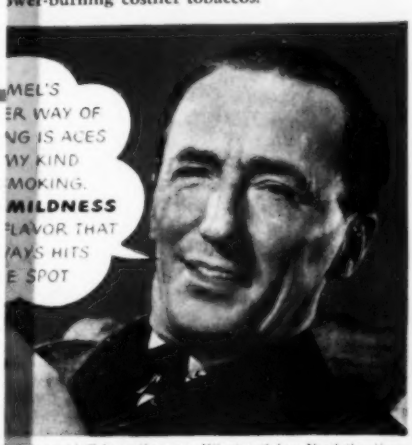

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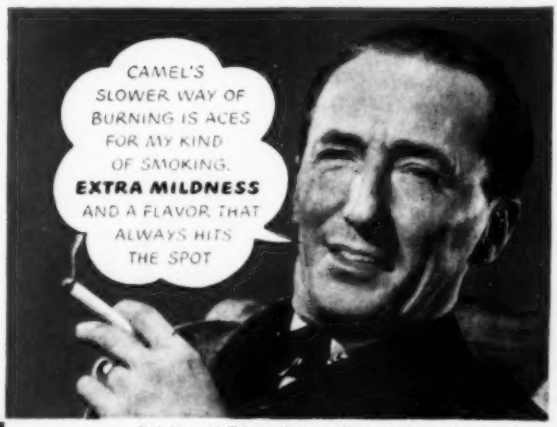

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